United States Army Aviation Logistics School
Fort Eustis, Virginia

APRIL 1994

THIS DOCUMENT HAS BEEN REVIEWED FOR OPSEC CONSIDERATIONS

STUDENT HANDOUT

UTILITY SYSTEMS

071-612-06

The proponent for this SH is USAALS

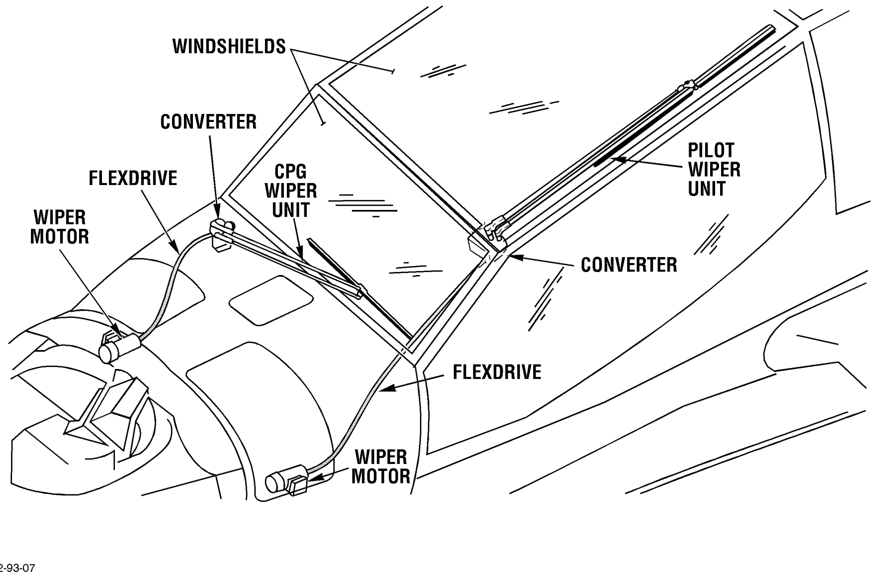
TERMINAL LEARNING OBJECTIVE:

At the completion of this lesson you will:

ACTION:	Analyze utility systems malfunctions.
CONDITIONS:	Given an AH-64A helicopter, TM 1-1520-238-T series manuals, TM 55-1520-238-23 series manuals, TM 55-1520-238-10, TM 55-1520-238-CL, TM 55-1520-238-MTF, and a requirement to analyze malfunctions within the AH-64A utility system.
STANDARDS:	Analyze AH-64A utility systems malfunctions with a minimum of 70% accuracy.

SAFETY REQUIREMENTS: In addition to the specific safety requirements of this lesson plan, aviation shop and flight line safety standards established in the technical manuals will be reinforced.

WINDSHIELD WIPER SYSTEM



NOTES

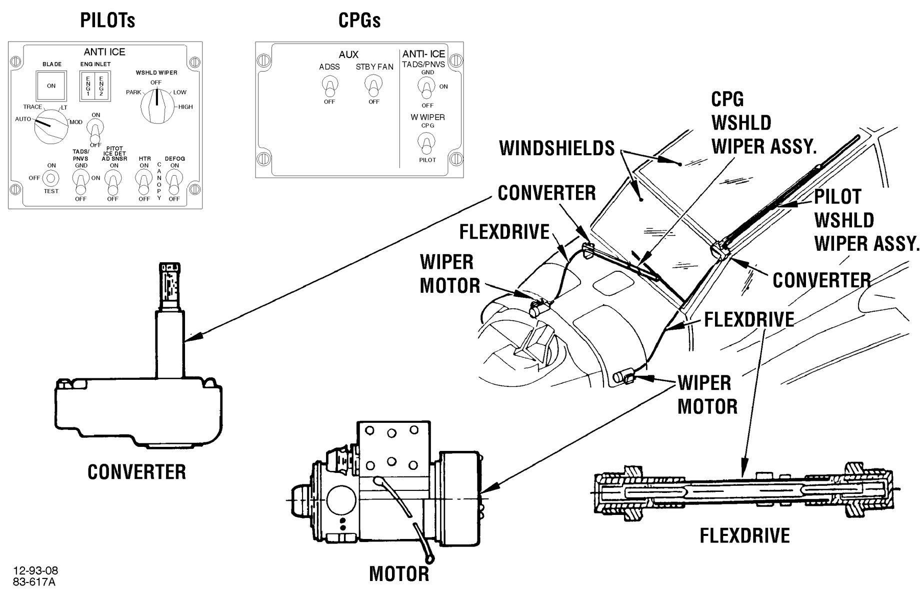
A. Windshield wiper system

1. Provides a means of removing moisture from the pilot's and copilot/gunner's (CPG's) windshields.

2. Can be operated at two speeds: low and high.

3. Can provide windshield clearing in heavy rain conditions up to 1.6 inches (4.1 centimeters) per hour, at airspeeds up to 204 knots.

WINDSHIELD WIPER SYSTEM COMPONENTS



NOTES

4. Major components

   a. Pilot windshield wiper (WSHLD WIPER) switch

   b. CPG windshield wiper (W WIPER) switch

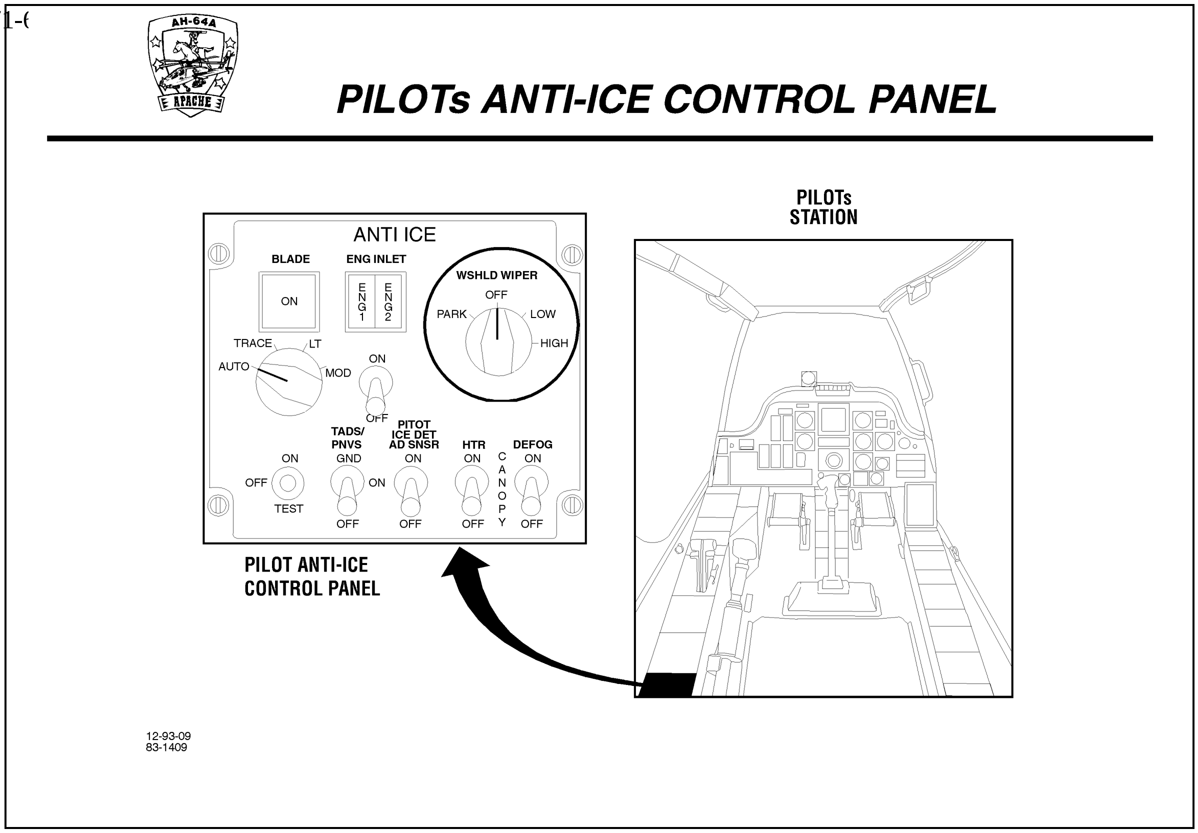
   c. Windshield wiper motors (2)

   d. Flexible drive shafts (flex drive)

   e. Converters (2)

   f. Windshield wiper assemblies

   g. Circuit breaker (not shown)


AH-64A
APACHE
PILOTs ANTI-ICE CONTROL PANEL
PILOTs
STATION
ANTI ICE
BLADE
ON
ENG INLET
ENG 1
ENG 2
WSHLD WIPER
OFF
PARK
LOW
HIGH
TRACE
LT
AUTO
MOD
ON
OFF
TADS/
PNVS
PITOT
ICE DET
AD SNSR
HTR
DEFOG
ON
OFF
TEST
GND
ON
OFF
CANOPY
PILOT ANTI-ICE
CONTROL PANEL
12-93-09
83-1409

NOTES

5. Pilot's windshield wiper switch

   a. Provides the pilot full control of the pilot and CPG crewstation windshield wiper motor, when the CPG's windshield wiper switch is in the PLT position.

   b. Located on the Anti-Ice control panel in the pilot's left console.

   c. Four-position rotary switch.

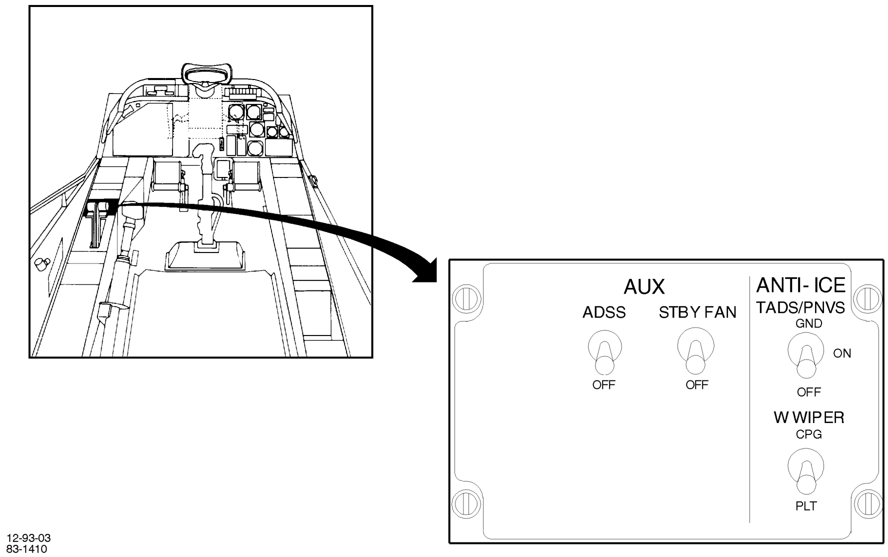
      (1) OFF - Windshield wipers off.

      (2) LOW - Windshield wipers operate at low speed.

      (3) HIGH - Windshield wipers operate at high speed.

      (4) PARK - Moves the windshield wipers to the stow position (this position is spring-loaded to the OFF position).

CPGs AUX/ANTI-ICE CONTROL PANEL



NOTES

6. CPG windshield wiper (W WIPER) switch

   a. Allows the CPG to select low speed windshield wiper operation, regardless of the pilot's windshield wiper switch position.

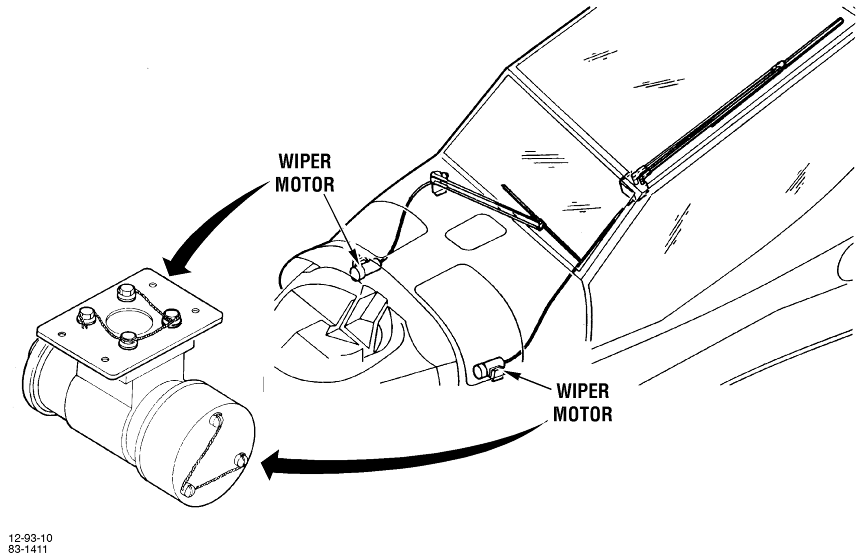
   b. Located on the auxiliary/anti-ice (AUX/ANTI-ICE) control panel in the CPG's left console.

   c. Two-position toggle switch.

      (1) PLT - Gives the pilot control of the windshield wiper system.

      (2) CPG - Allows the CPG to select low speed operation for the CPG's windshield wiper, regardless of the pilot's windshield wiper switch position.

WINDSHIELD WIPER MOTORS



NOTES

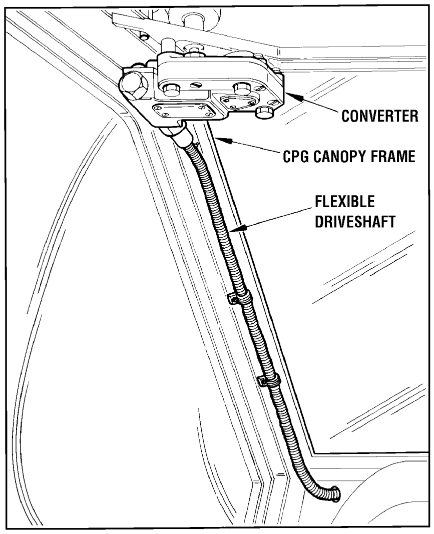
7. Windshield wiper motors

   a. Located in the left (pilot's) and right (CPG's) nose equipment bays.

   b. Unidirectional, noise-filtered (a filter that is inserted in a power line to block noise interference that would otherwise travel through the line and affect the operation of receivers), continuous-duty motor, rated at 28 volts direct current (VDC), 10 amperes. Contains an internal limit switch for the park position.

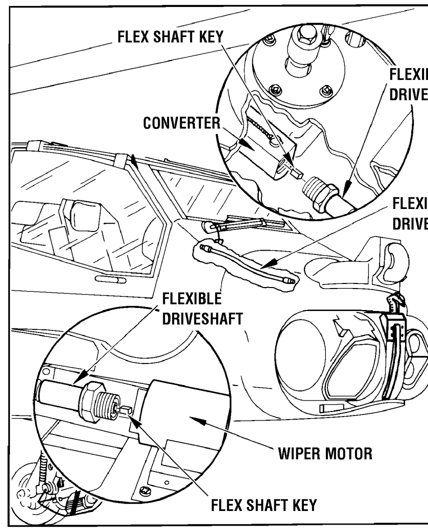
WINDSHIELD WIPER FLEXIBLE DRIVESHAFTS AND CONVERTERS

PILOT CONVERTER AND DRIVESHAFT



12-93-11
85-569

CPG CONVERTER AND DRIVESHAFT



NOTES

NOTE

To ensure proper installation of flex shaft, flex shaft key must be installed between flex shaft and converter fitting.

8. Flexible drive shafts

   a. A flexible cable transmits rotary output of each motor to the converter.

   b. One flexible drive shaft is connected between each wiper motor and converter.

   c. Flex shaft key inside both end fittings of flexible drive shafts can fall free of flex drive when cable is removed.

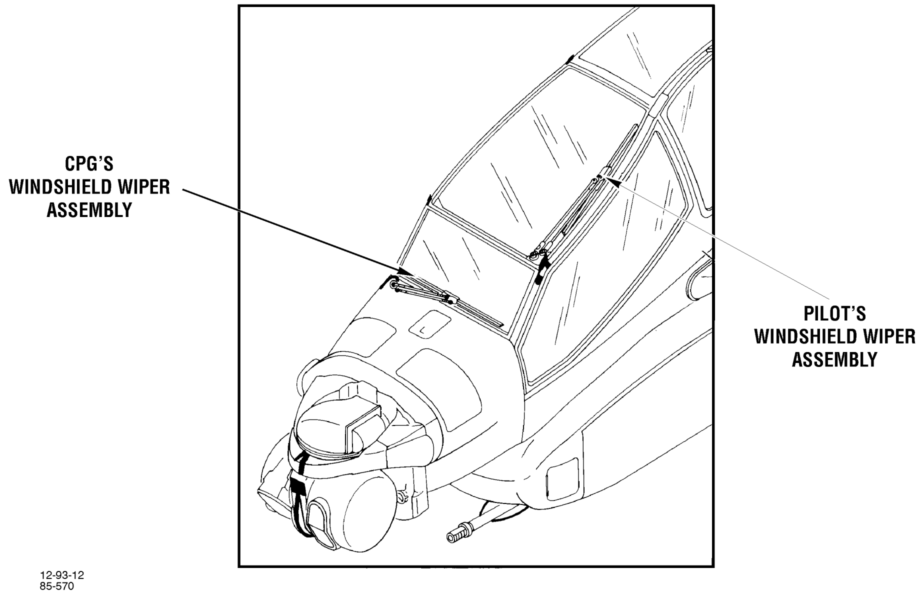
9. Converters

   a. Reduce the wiper motor input speed to the wiper assemblies, and convert rotary motion to oscillating motion.

   b. The pilot's converter is mounted on the left canopy frame in the CPG's crewstation.

   c. The CPG's converter is mounted forward of the canopy frame on the right side of the nose section.

WINDSHIELD WIPER ASSEMBLIES



NOTES

10. Windshield wiper assemblies

   a. The pilot's wiper assembly is mounted on the canopy frame, lower left side of the windshield.

   b. The CPG's assembly is mounted on the airframe, right side just below the windshield.

   c. The windshield wiper assemblies consist of the wiper arm, the link, and the wiper blade.

   d. During all phase maintenance inspections the windshield wiper system components are inspected.

      (1) Wiper blades - damage and wear.

      (2) Wiper arms - damage, wear, and missing hardware.

      (3) Wiper links - damage, wear, and missing hardware.

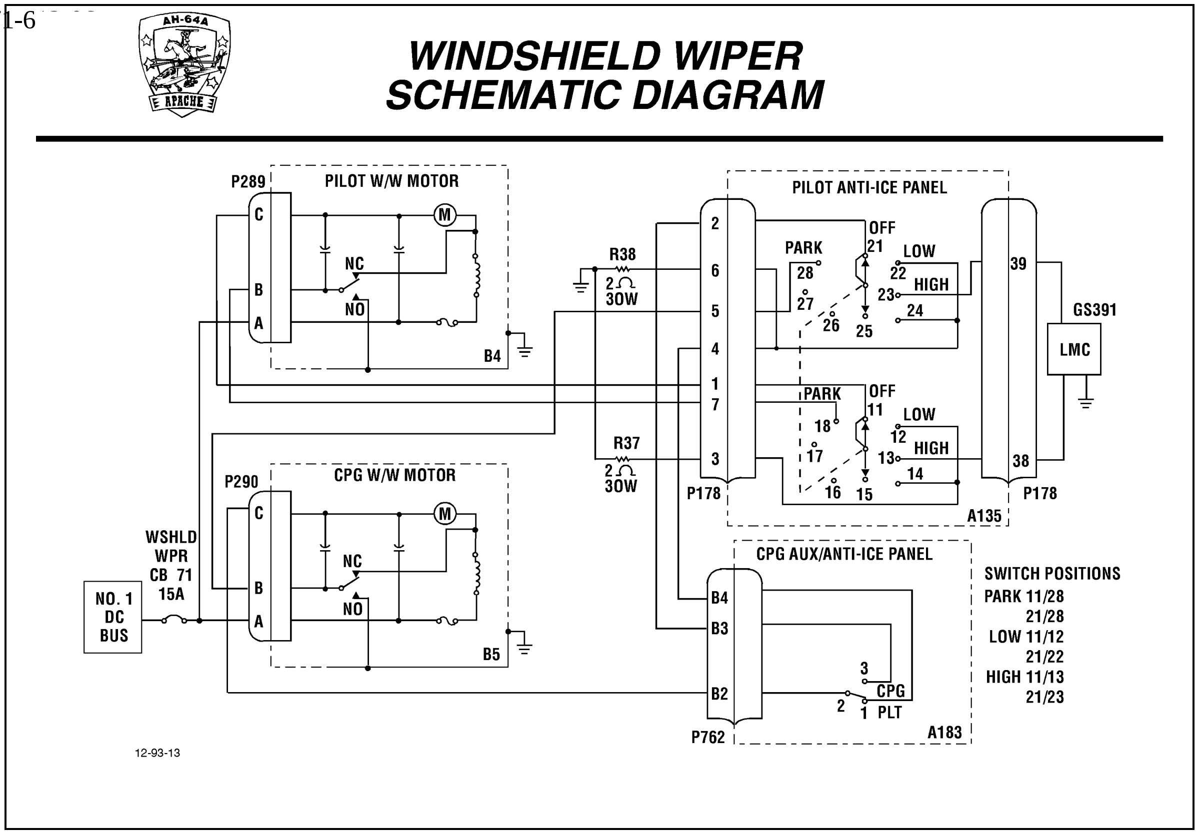
      (4) Converters - cracks and dents.

      (5) Flexdrives - loose hardware, cuts, nicks, or kinks.

      (6) Wiper motor - damaged connector, loose screws, kinked flexdrive, cracks, or dents.

CAUTION

Keep pilot and CPG windshields wet with distilled or fresh, clean water while operating windshield wipers to prevent scratches.



AH-64A
APACHE
WINDSHIELD WIPER
SCHEMATIC DIAGRAM
P289
PILOT W/W MOTOR
C
B
A
M
NC
NO
B4
R38
2 Ω
30W
R37
2 Ω
30W
P290
CPG W/W MOTOR
B5
WSHLD
WPR
CB 71
15A
NO. 1
DC
BUS
PILOT ANTI-ICE PANEL
PARK
OFF
LOW
HIGH
P178
A135
GS391
LMC
CPG AUX/ANTI-ICE PANEL
B4
B3
B2
CPG
PLT
P762
A183
SWITCH POSITIONS
PARK 11/28
21/28
LOW 11/12
21/22
HIGH 11/13
21/23
12-93-13

NOTES

11. Pilot's crewstation operation

a. 28 VDC is applied to both motors from the No. 1 DC Bus, via circuit breaker number 71 (CB71).

b. With the CPG's W WIPER motor switch in the PLT position, control of both wipers depends on the position of the pilot's WSHLD WIPER switch.

c. LOW position selected by the pilot

(1) The top wafer routes current

(a) From ground via R37 to P178-3.

(b) Through contacts 12 and 11 of the pilot's switch, through P178-1 to P289-C, through the pilot's motor field to 28 VDC.

(c) R37 reduces current flow, causing low speed operation of the pilot's motor.

(d) As soon as the motor leaves the PARK position, the internal limit switch changes from the normally closed (NC) position to the normally open (NO) position.

(2) The bottom wafer routes current

(a) From ground through current-limiting resistor R38 to P178-6.

(b) Through contacts 22 and 21 of the pilot's switch and out P178-2.

(c) In P762 B4, through contacts 1 and 2 of the CPG's switch, and out P762 B2.

(d) In P290-C, through the CPG's motor field to 28 VDC.

(e) This causes the CPG's motor to operate at low speed.

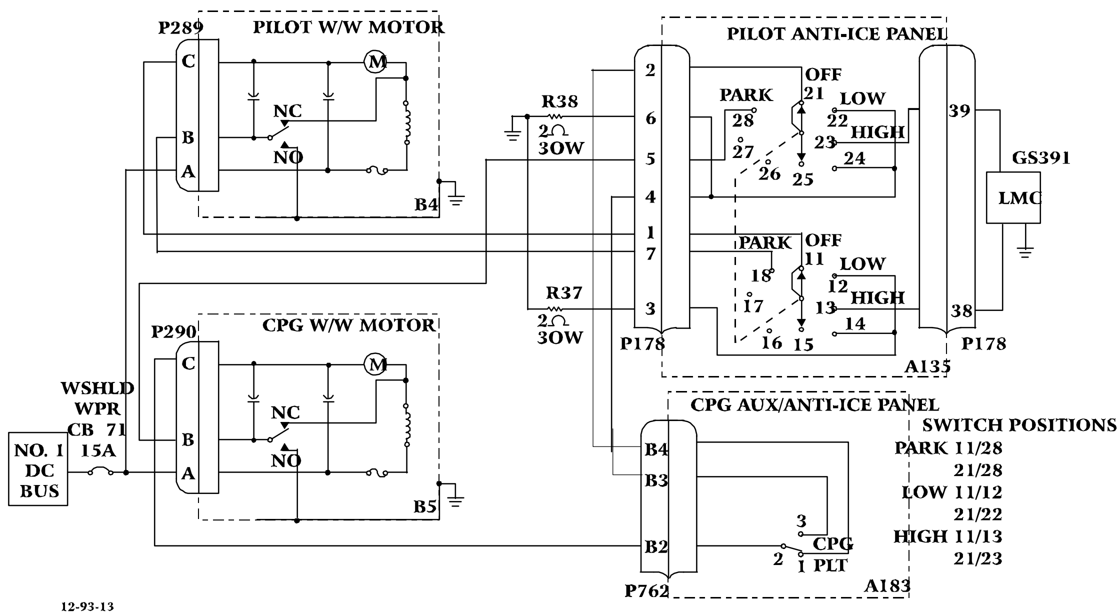
(f) As soon as the motor leaves the park position, the internal limit switch changes from the NC position to the NO position.

d. HIGH position selected by the pilot

(1) The top wafer routes current flow

(a) From ground at GS391-M through contacts 13 and 11 of the pilot's switch.

WINDSHIELD WIPER SCHEMATIC DIAGRAM



(b) From P178-1 to P289-C of the pilot's motor.

(c) Through the motor field and out P289-A to power.

(d) This causes the pilot's motor to operate at high speed.

(2) The bottom wafer routes current flow

(a) From ground at GS391-L through contacts 23 and 21 of the pilot's switch.

(b) Out P178-2 to P762 B4.

(c) Through contacts 1 and 2 of the CPG's switch and out P762 B2.

(d) In P290-C, through the CPG's motor, and out P290-A to power.

(e) This causes the CPG's motor to operate at high speed.

e. PARK position selected by the pilot

NOTE: The PARK position is a momentary contact position, spring loaded to OFF. The limit switch (marked NC/NO) in each motor is shown on the schematic in the PARK (NC) position. When the motor is not in PARK, the switch is in the NO position.

(1) Contacts 11/18 of the top wafer and contacts 21/28 of the bottom wafer close.

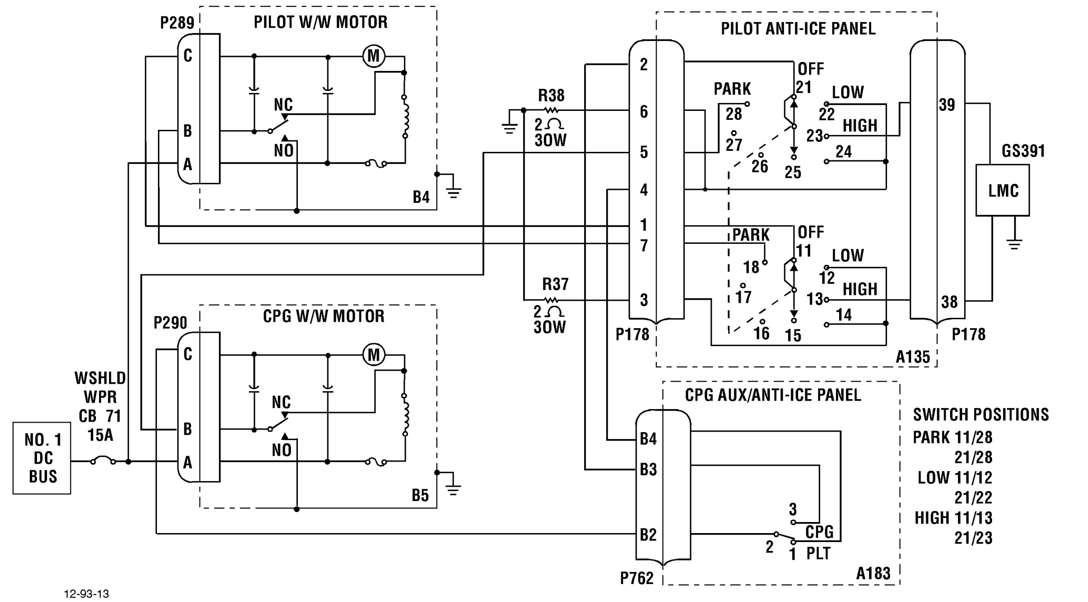
(2) The top wafer routes current flow from ground on the case of motor B4, through the closed NO contacts of the motor limit switch, out pin B of P289 into pin 7 of P178.

(a) From pin 7 of P178, current flows to contact 18, which is jumpered to contact 11, out pin 1 of P178, into pin C of P289, through the motor, and to 28 VDC at pin A of P289.

(b) The motor drives until the limit switch changes from the NO position to the NC position when the motor reaches the park position.

(3) The bottom wafer routes current flow from ground on the case of motor B5, through the closed NO contacts of the motor limit switch, out pin B of P290 into pin 5 of P178.

WINDSHIELD WIPER SCHEMATIC DIAGRAM



NOTES

(a) From pin 5 of P178, current flows to contact 28, which is jumpered to contact 21, out pin 2 of P178, and into B4 of P762; through contacts 1 and 2 of the CPG's wiper switch, out pin B2 of P762 into pin C of 290, through the motor, and to 28 VDC at pin A of P290.

(b) The motor drives until the limit switch changes from the NO position to the NC position when the motor reaches the PARK position.

12. CPG crewstation operation

a. The CPG windshield wiper motor may be operated at low speed, regardless of the position of the pilot's WIPER switch.

b. With the CPG W WIPER switch placed in the CPG position, current flows

(1) From ground through R38 to P178-6.

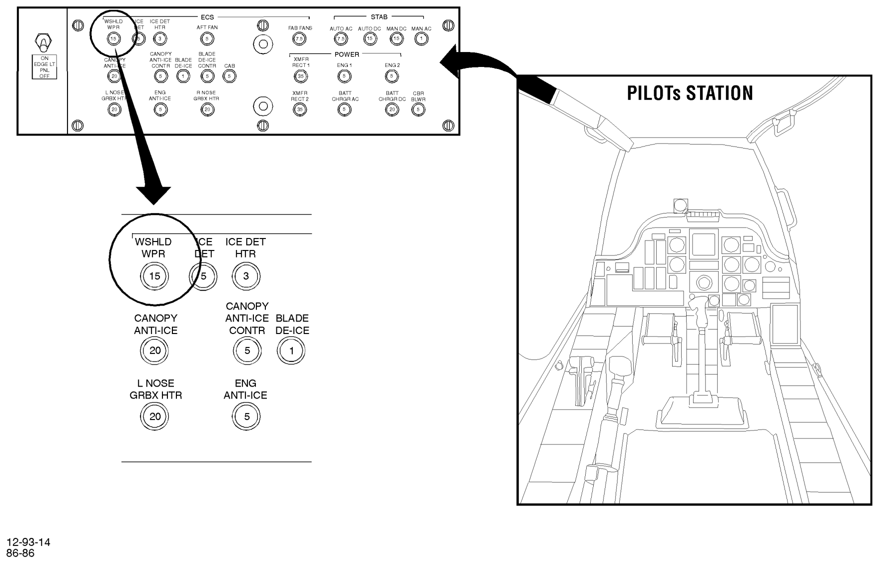
(2) Out P178-4 to 762 B3.

(3) Through contacts 3 and 2 of the CPG's switch and out P762 B2.

(4) In P290-C through the motor field to 28 VDC.

c. The CPG'S windshield wiper operates at low speed as long as CPG position is selected.

WINDSHIELD WIPER CIRCUIT BREAKER



NOTES

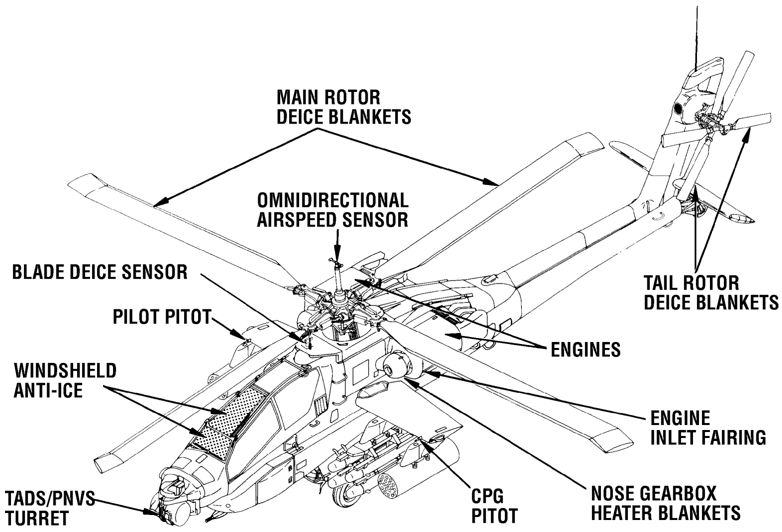
13. Circuit breaker

    a. Provides circuit protection for windshield wiper system.

    b. Located on the pilot's AFT circuit breaker panel.

    c. CB71 is a 15 amp circuit breaker powered by the No. 1 essential DC Bus.

ANTI-ICE AND DEICE LOCATIONS



12-92-08

NOTES

WARNING

HIGH VOLTAGE

All ground handling personnel must be informed of high voltage hazards when working near Target Acquisition Designator Sight (TADS) and Pilot Night Vision Sensor (PNVS) equipment.

A. Anti-ice and deice system - The term "anti-ice" means the application of heat to prevent ice buildup. The term "deice" means the application of heat to remove ice buildup.

1. Components that incorporate anti-ice or deice capabilities

a. PNVS window

b. TADS windows

c. Windshield anti-ice

d. Pilot pitot tube

e. CPG pitot tube

f. Blade deice sensor (housing)

g. Blade deice sensor probe deicing

h. Omnidirectional airspeed sensor

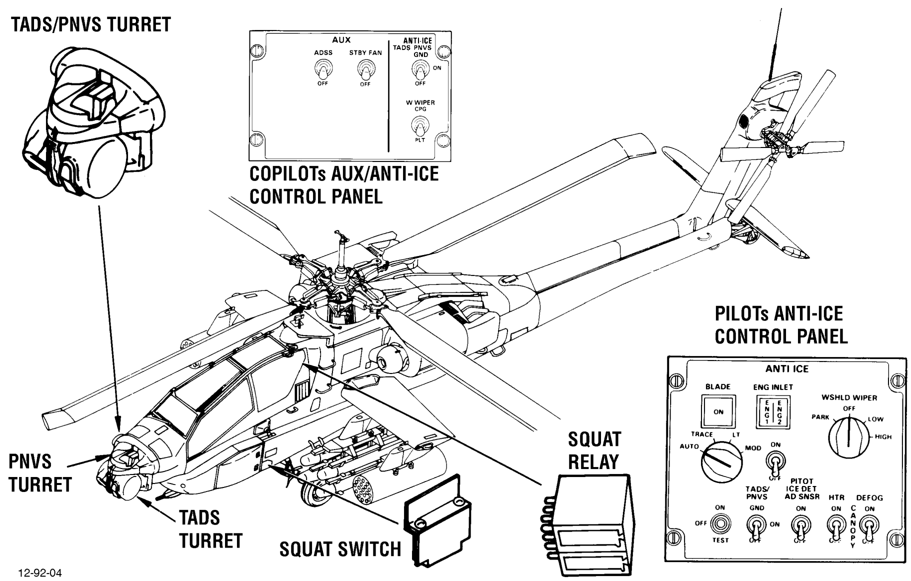
i. Engine inlet fairing anti-ice

j. Engine inlets

k. Engine nose gearbox fairings

l. Main and tail rotor

TADS/PNVS ANTI-ICE



NOTES

2. TADS/PNVS anti-ice system

   a. Prevents the formation of ice on the PNVS window and TADS system day, night, and boresight module windows.

   b. The TADS night side assembly (NSA) and PNVS window assembly, is made of germanium mounted in a fiberglass housing.

   c. Germanium is a brittle, water insoluble, silvery-gray metallic element in the carbon family: symbol Ge, atomic number 32, atomic weight 72.59, melting point 1,758.2EF (959EC). It is a rare metal used in semiconductors, alloys, and glass.

   d. Heater wires are embedded in the fiberglass housing and attached to the germanium window assemblies. The heater wires apply voltage to the germanium which causes it to heat up, providing anti-ice capability.

   e. The TADS day side assembly (DSA) window is similar in operation to the PNVS/TADS NSA windows, however a conducting film is used in place of the germanium.

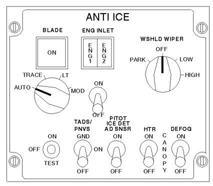
   f. A temperature sensor and thermostat are bonded to the window assembly.

   g. The anti-ice circuit card assembly (CCA) contains an electrostatic sensitive (ESS) device, and requires special preparation for storage or shipment when removed from the PNVS shroud assembly. See TM 11-5855-265-30.

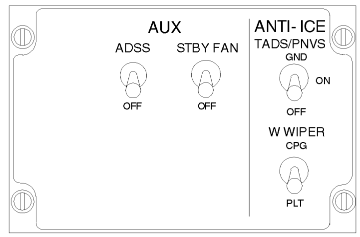
TADS/PNVS ANTI-ICE SYSTEM MAJOR COMPONENTS

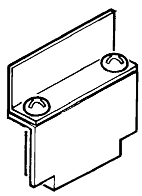
TADS/PNVS CONTROL SWITCHES

PILOTs STATION

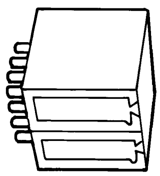


CPGs STATION





SQUAT SWITCH



SQUAT RELAY

12-93-15
83-1446

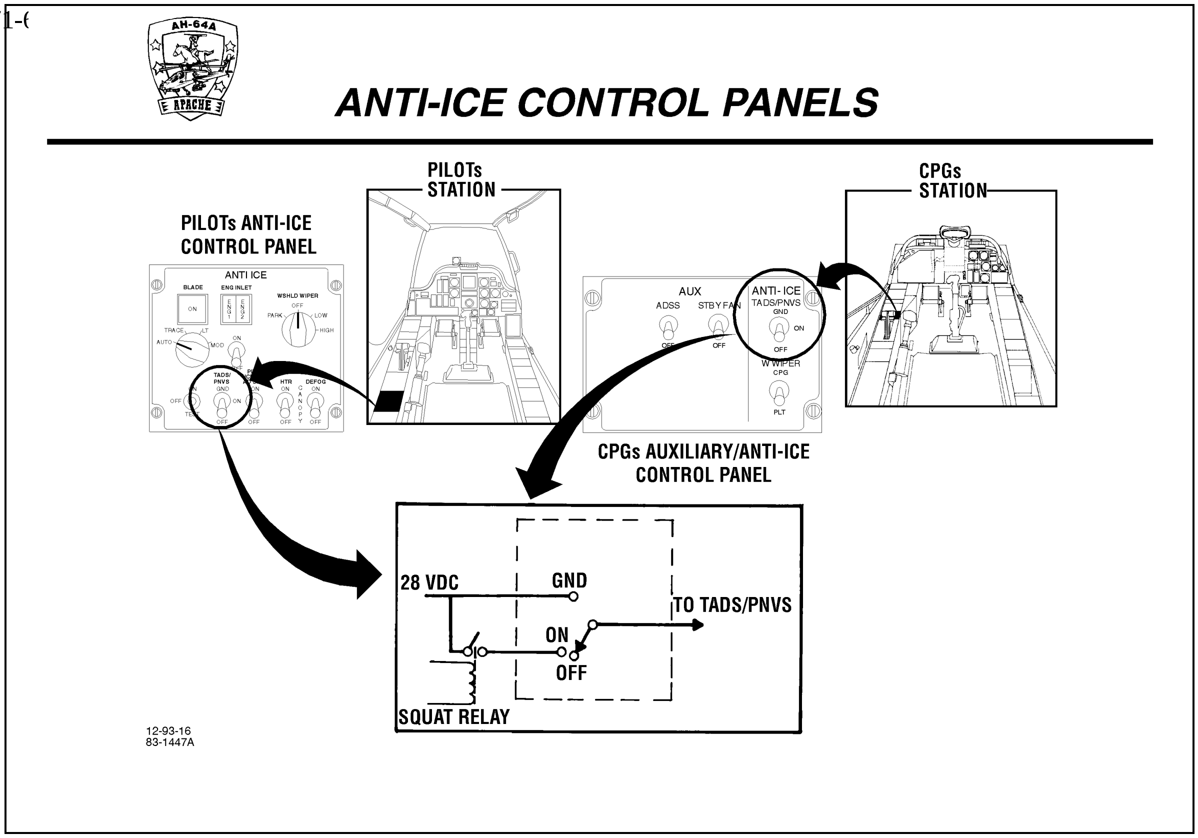
NOTES

h. TADS/PNVS anti-ice system major components

(1) TADS/PNVS anti-ice control switches

(2) Squat switch

(3) Squat relay


AH-64A
APACHE
ANTI-ICE CONTROL PANELS
PILOTs STATION
CPGs STATION
PILOTs ANTI-ICE CONTROL PANEL
ANTI ICE
BLADE
ENG INLET
WSHLD WIPER
TADS/PNVS
GND
ON
OFF
HTR
DEFOG
AUX
ADSS
STBY FAN
ANTI-ICE
W WIPER
CPG
PLT
CPGs AUXILIARY/ANTI-ICE CONTROL PANEL
28 VDC
GND
ON
OFF
TO TADS/PNVS
SQUAT RELAY
12-93-16
83-1447A

NOTES

i. Anti-ice control panel switches

(1) Allow either crew member to engage the respective TADS/PNVS anti-ice system.

(2) Allow the system to be ground tested.

(3) The pilot's TADS/PNVS control switch is located on the ANTI-ICE control panel in the pilot's left console.

(4) The CPG's TADS/PNVS control switch is on the AUX/ANTI-ICE control panel in the CPG's left console.

(5) The switch is a three-position (GND, ON, and OFF) toggle switch.

j. Operation of anti-ice control

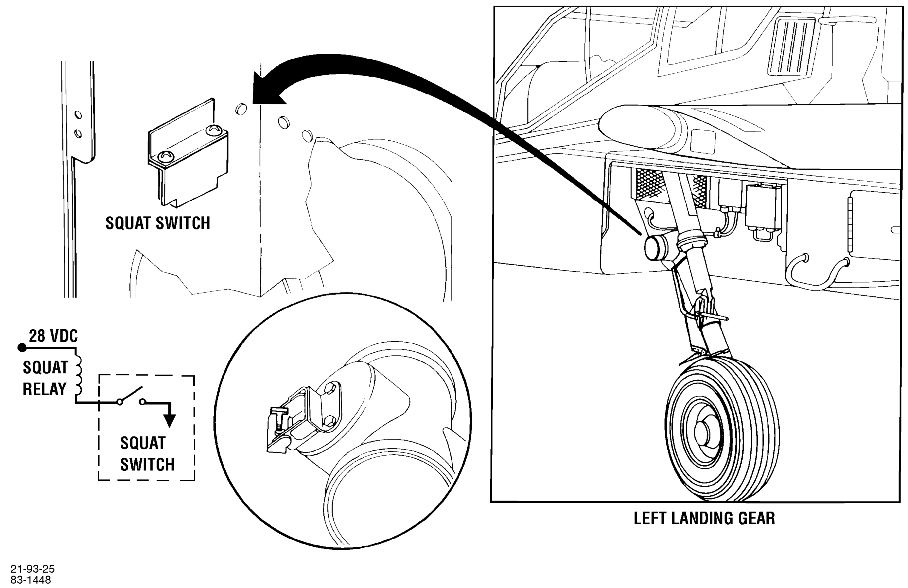
(1) GND position is directly connected to 28 VDC and is used to functionally check the system on the ground or for prevention of ice build-up during ground operations.

(2) ON position is connected to 28 VDC via the squat relay and is operational in the air only.

(3) 28 VDC is used as a control voltage only. Deice heater voltage is 115 VAC.

(4) The OFF position de-energizes the TADS/PNVS anti-ice system.

SQUAT SWITCH



NOTES

k. Squat switch

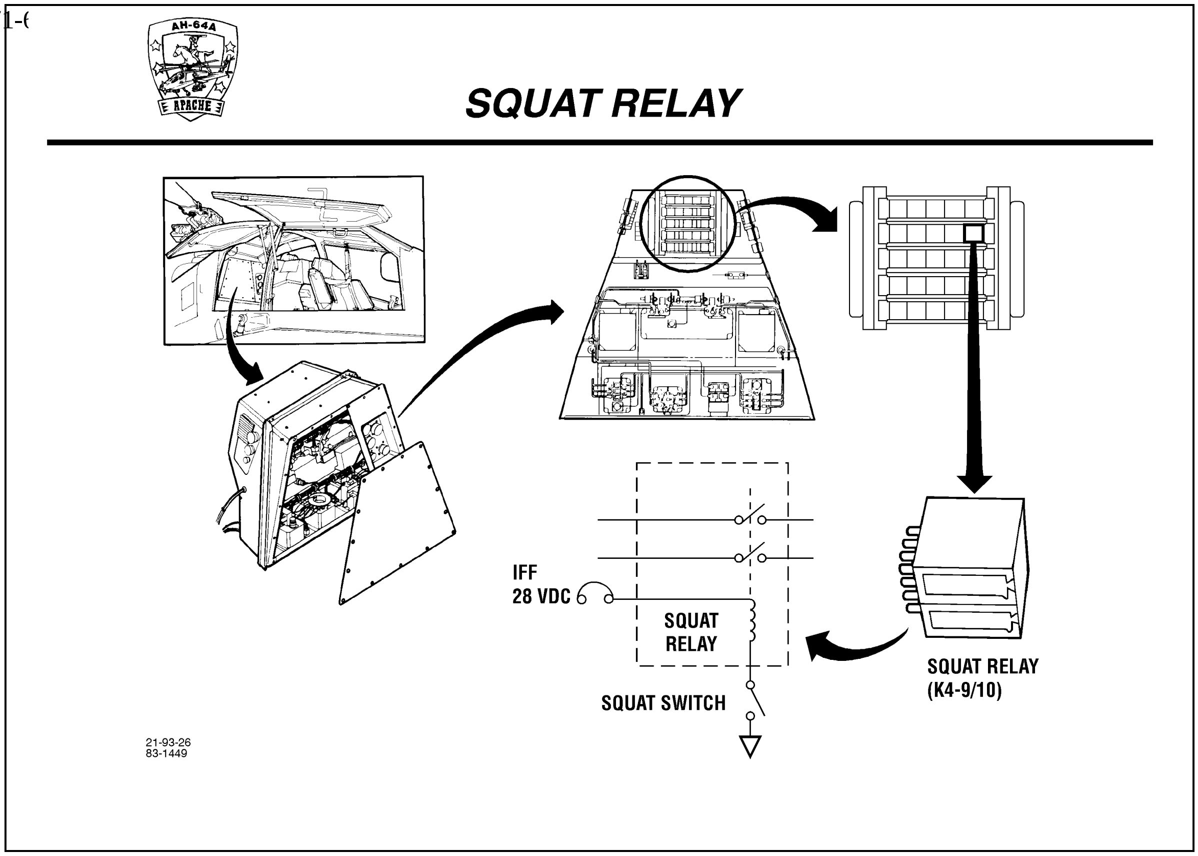
(1) Controls operation of the squat relay.

(2) Located on the left main landing gear.

(3) Solid state magnetic switch.

(a) With the aircraft on the ground, the switch is open and the ground is removed from the return side of the squat relay coil.

(b) With the aircraft in the air, the switch is closed and a ground is supplied to the return side of the squat relay coil.


AH-64A
APACHE
SQUAT RELAY
IFF
28 VDC
SQUAT
RELAY
SQUAT SWITCH
SQUAT RELAY
(K4-9/10)
21-93-26
83-1449

NOTES

l. Squat relay

(1) Controls 28 VDC from the No. 1 DC Bus to the ON contacts of the respective PILOT and CPG TADS/PNVS control switches.

(2) De-energizes the TADS/PNVS anti-ice system upon touchdown to protect maintenance personnel from a possible shock hazard if they should come in contact with a damaged germanium-coated heater on the TADS/PNVS windows.

(3) Located in the electrical power distribution center behind the pilot's seat.

(4) All components in the electrical power distribution center are inspected during all phase maintenance inspections.

(5) The wiring harnesses are inspected for security, chafing, and cleanliness.

(6) The relay is a small [1 x 1 inch (2.5 x 2.5 x 2.5 centimeters)], lightweight [1.4 ounce (39.6 grams)], solid state line replaceable unit (LRU).

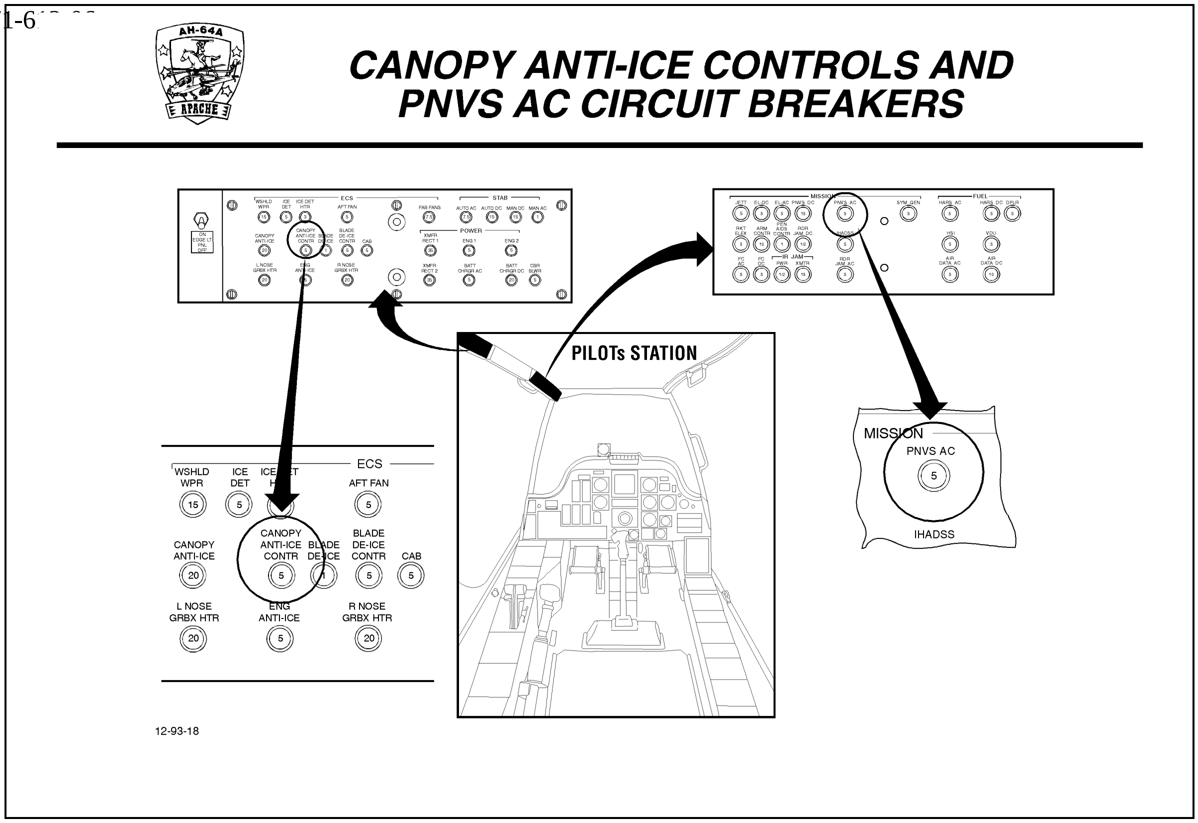
(7) Operation

(a) Coil side is powered by 28 VDC from the emergency DC Bus via the identification friend or foe (IFF) circuit breaker.

(b) Return side ground is controlled by the squat switch.

1) With the aircraft on the ground, the squat switch is open, and squat relay de-energized.

2) With the aircraft in the air, the squat switch is closed, and a ground is provided to the return side of the squat relay. This causes the squat relay to energize.


AH-64A
APACHE
CANOPY ANTI-ICE CONTROLS AND
PNVS AC CIRCUIT BREAKERS
PILOTs STATION
ECS
WSHLD WPR
ICE DET
AFT FAN
15
5
5
CANOPY ANTI-ICE
CANOPY ANTI-ICE CONTR
BLADE DE-ICE
BLADE DE-ICE CONTR
CAB
20
5
5
5
L NOSE GRBX HTR
ENG ANTI-ICE
R NOSE GRBX HTR
20
5
20
MISSION
PNVS AC
5
IHADSS
12-93-18

NOTES

m. Canopy anti-ice control circuit breaker (CB70)

(1) Provides circuit protection for the 28 VDC TADS/PNVS heater control circuitry.

(2) Located on the pilot's aft overhead circuit breaker panel.

(a) Rated at 28 VDC and 5 amperes.

(b) Powered by the No. 1 DC Bus.

(c) Supplies 28 VDC control power for the TADS/PNVS anti-ice circuitry.

n. PNVS AC circuit breaker (CB81)

(1) Provides circuit protection for the 115/200 VAC PNVS heater circuitry.

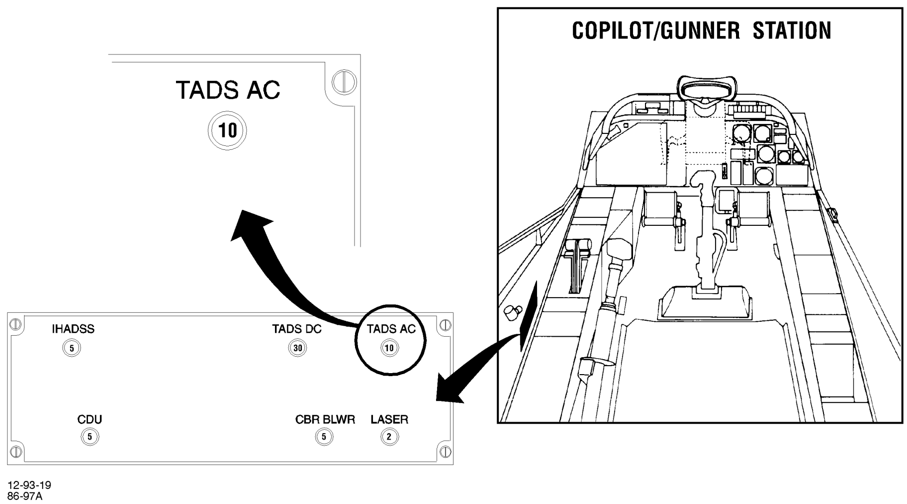
(2) Located on the pilot's forward overhead circuit breaker panel.

(a) Ganged, three-phase, 115/200 VAC circuit breaker rated at 5 amperes.

(b) Powered by the No. 1 AC Bus.

(c) Only phase A is used for PNVS heater power.

TADS AC CIRCUIT BREAKER



NOTES

o. TADS AC circuit breaker (CB167)

(1) Provides circuit protection for the 115/200 VAC TADS heater circuitry.

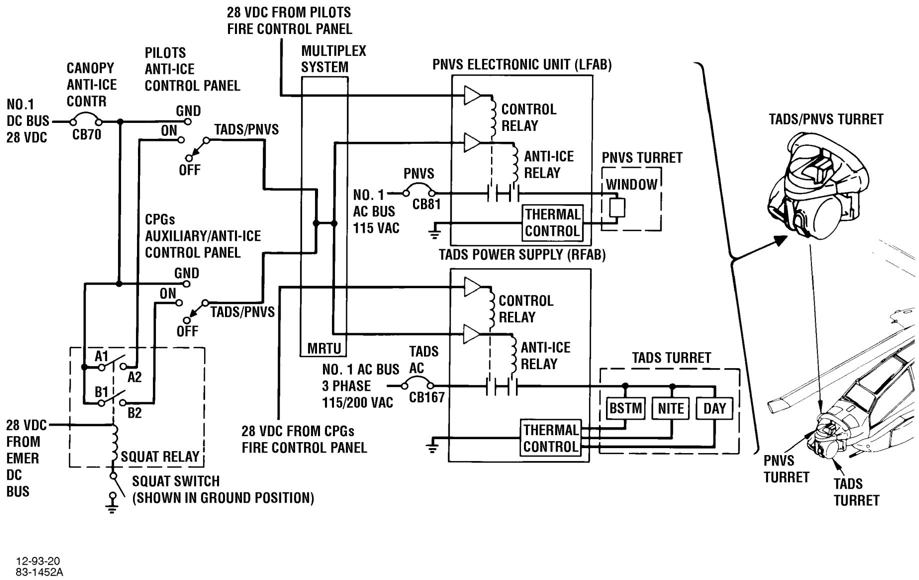
(2) Located on the No. 2 circuit breaker panel in the CPG's left console.

(a) Ganged, three-phase, 115/200 VAC circuit breaker rated at 10 amperes.

(b) Powered by the No. 1 AC Bus

(c) Supplies three-phase, 115/200 VAC TADS heater power.

TADS/PNVS ANTI-ICE SCHEMATIC DIAGRAM



NOTES

3. TADS/PNVS anti-ice operation

a. Ground mode

(1) With the aircraft on the ground, the squat switch is open, and squat relay (K4-9/10) is de-energized. This causes squat relay contacts A1, A2, B1, and B2 to open.

(2) 28 VDC from the canopy anti-ice circuit breaker (CB70) connects directly to the GND contacts of both crew stations TADS/PNVS ANTI-ICE control switches.

(3) When the pilot's PNVS switch is placed to the ON position, single-phase 115/200 VAC heater voltage is applied directly to the PNVS electronic unit (PEU) from the PNVS circuit breaker (CB81).

(4) When the CPG's TADS switch is placed in the ON position, three-phase 115/200 VAC TADS heater voltage is applied directly to the TADS power supply (TPS) from the TADS AC circuit breaker (CB167).

(5) The PNVS switch must be in the ON position to allow the PNVS anti-ice control relay in the PEU to energize. The TADS switch must also be in the ON position to allow the TADS anti-ice control relay in the TPS to energize.

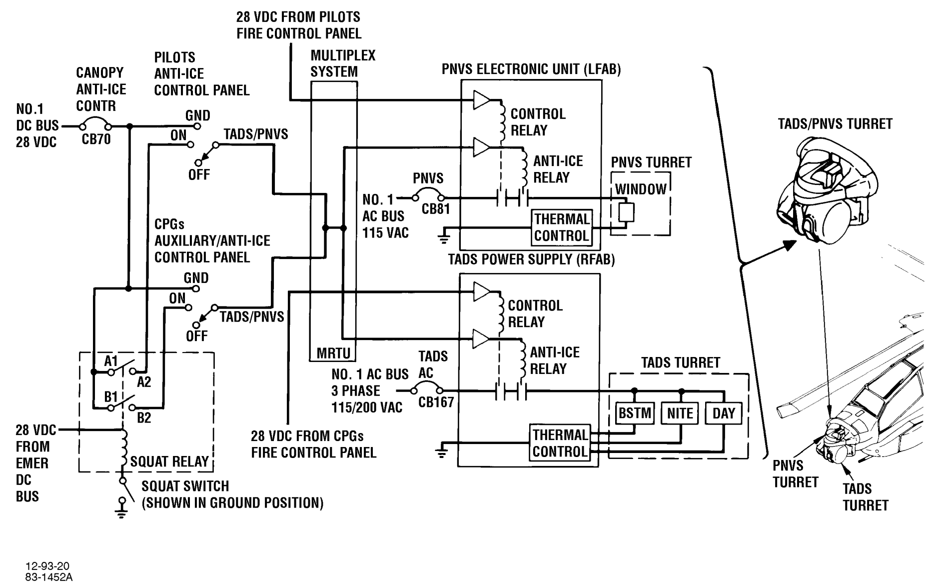
(6) Placing the pilot or CPG TADS/PNVS ANTI-ICE control switch in the GND position applies 28 VDC from CB70, to the Type I multiplex remote terminal unit (MRTU) in the left forward avionics bay (FAB). This causes the MRTU to route a logic signal to energize anti-ice relays in the TPS and PEU.

(7) Single-phase 115/200 VAC heater voltage is then applied to the PNVS germanium window. Since germanium is a conductive material, it acts as a heating element as current flows through it.

(8) Three-phase 115/200 VAC heater voltage is applied to the TADS windows. The TADS day side assembly (DSA) window and boresight module window have an interior semi-conductive coating that increases in temperature as current flows through it. The TADS night side assembly (NSA) window anti-ice function operates the same as the PNVS window.

(9) TADS/PNVS window heating is automatically controlled by a thermal control sensor in the respective AC heater power return circuits.

TADS/PNVS ANTI-ICE SCHEMATIC DIAGRAM



NOTES

b. On (in flight) mode

(1) With the aircraft in the air, the squat switch is closed and a ground is supplied to the return side of the squat relay coil.

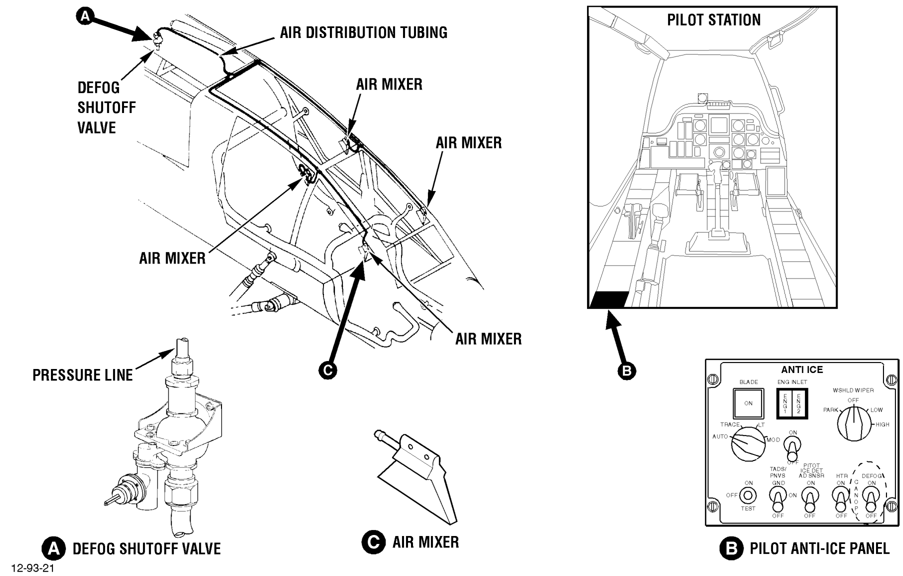
(2) This energizes the squat relay and closes contacts A1, A2, B1, and B2.

(3) 28 VDC from CB70 is routed to the ON contacts of the pilot and CPG TADS/PNVS control switches.

(4) With the TADS/PNVS control switch in the ON position, air operation is identical to the GND mode.

c. Off mode - system is de-energized.

CANOPY DEFOG SYSTEM MAJOR COMPONENTS



A DEFOG SHUTOFF VALVE

C AIR MIXER

B PILOT ANTI-ICE PANEL

NOTES

4. Canopy defog system

   a. Prevents or eliminates moisture (fogging) on the canopy side panels in both crew stations.

   b. Provides canopy side panel anti-icing.

   c. System major components

      (1) Defog shutoff valve

      (2) Defog control switch

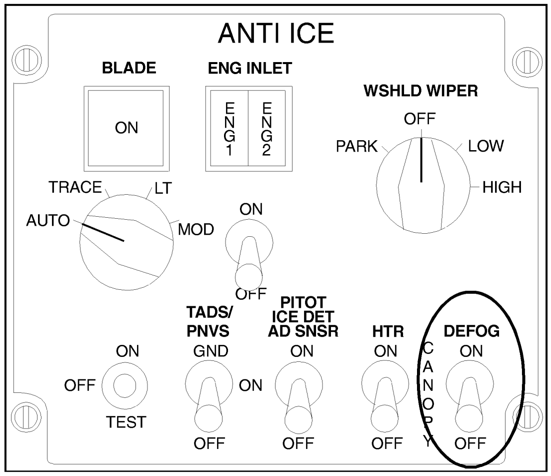
      (3) Air mixer

   d. The system is protected by the canopy ANTI-ICE CONTR circuit breaker

      (1) Rated at 28 VDC and 5 amperes.

      (2) Powered by the No. 2 DC Bus.

PILOTs ANTI-ICE CONTROL PANEL



12-93-22
83-1474

NOTES

e. Canopy DEFOG control switch

(1) Allows the pilot to control the opening and closing of the defog shutoff valve.

(2) Located on the ANTI-ICE control panel in the pilot's left console.

(3) Single-pole, double-throw, two-position (ON-OFF) switch.

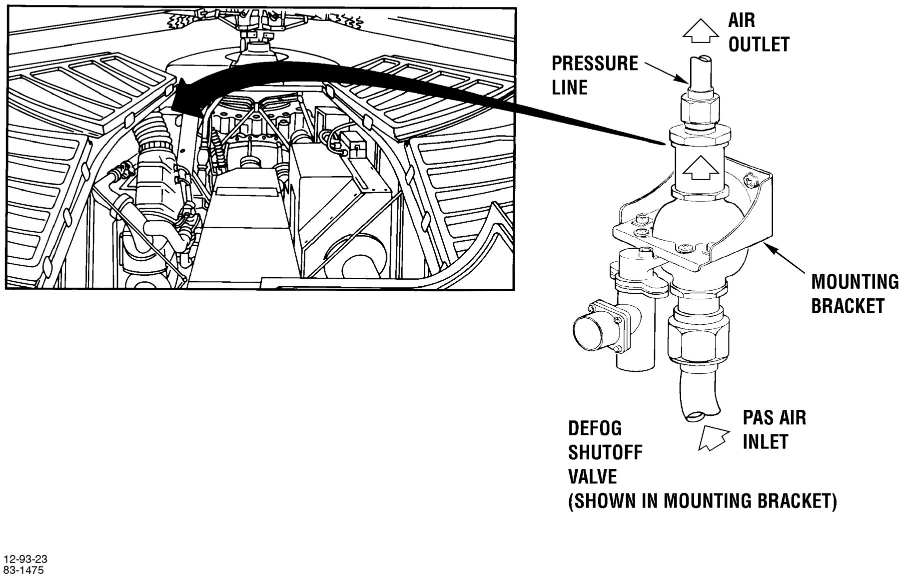
(4) Powered by 28 VDC from the No. 2 DC Bus via the canopy anti-ice control circuit breaker (CB70).

(5) Operation

(a) ON position routes 28 VDC to the canopy defog shutoff valve.

(b) OFF position removes 28 VDC from the canopy defog shutoff valve.

DEFOG SHUTOFF VALVE



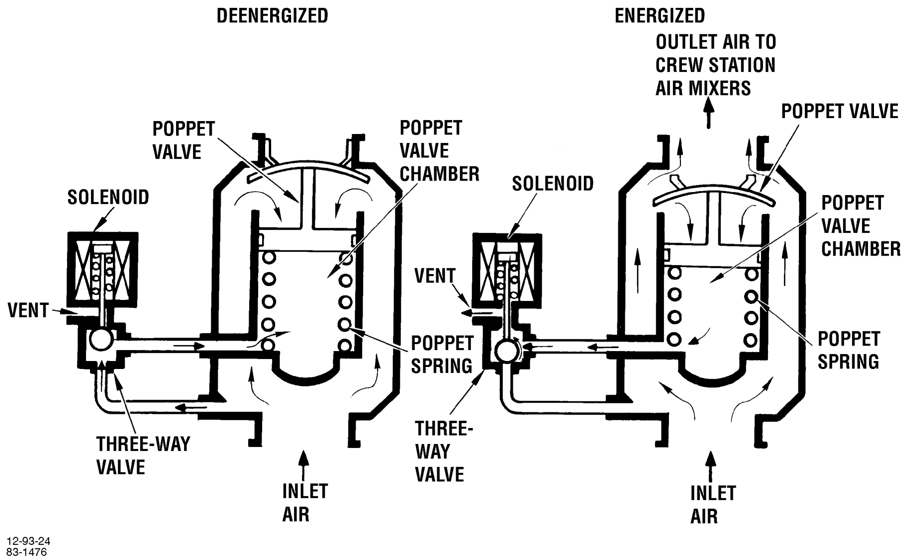
NOTES

f. Defog shutoff valve

(1) Provides ON/OFF control of hot air from the pressurized air system (PAS) manifold to the air mixers.

(2) Located in the aft equipment bay on the left engine louver housing.

DEFOG SHUTOFF VALVE DESCRIPTION



NOTES

g. The defog shutoff valve is a normally closed, 28 VDC electrically actuated, air-operated poppet valve.

h. Operation

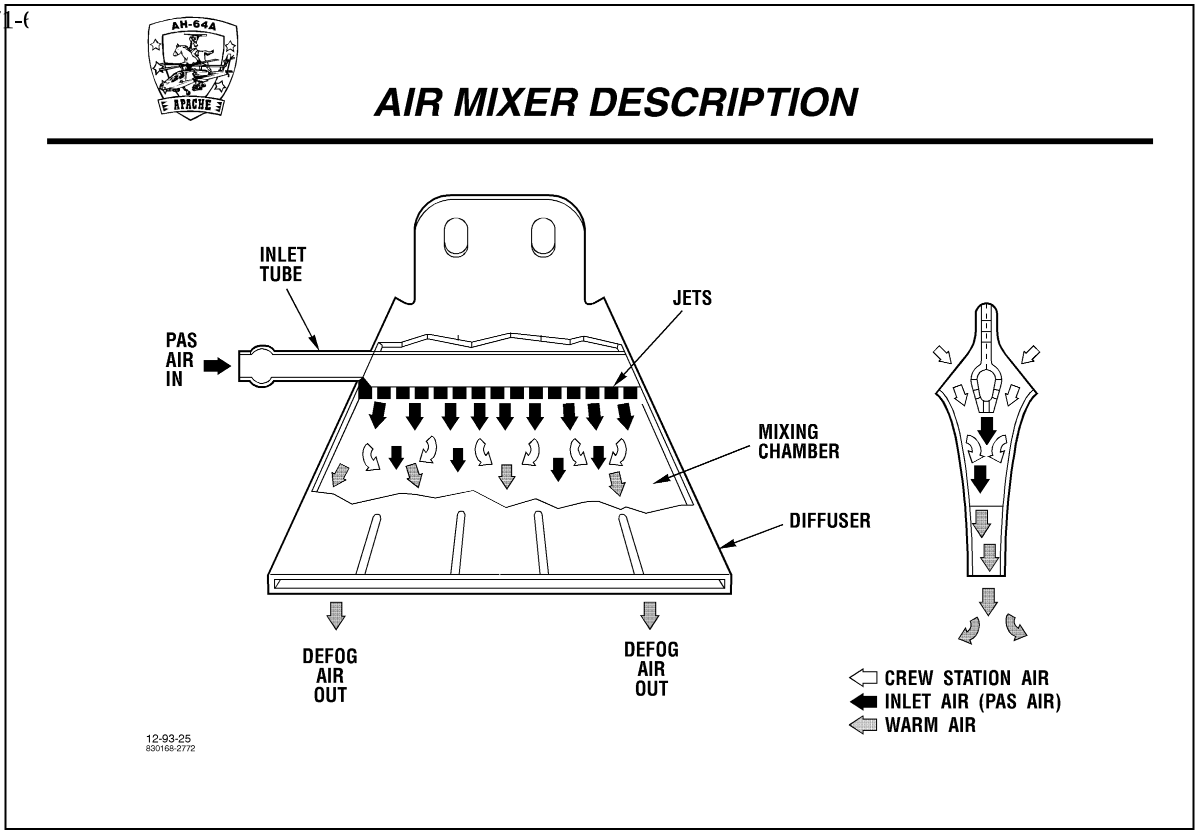
(1) De-energized - inlet air pressure through the three-way valve and to the poppet valve is equal. Spring pressure holds the valve closed.

(2) Energized

(a) Three-way valve shuts off inlet air and vents chamber pressure.

(b) Inlet pressure acting on the poppet valve overcomes spring pressure and opens the valve.

(3) All equipment in the aft equipment bay is inspected during the daily inspection and all phase maintenance inspections.


AIR MIXER DESCRIPTION
INLET TUBE
JETS
PAS AIR IN
MIXING CHAMBER
DIFFUSER
DEFOG AIR OUT
DEFOG AIR OUT
CREW STATION AIR
INLET AIR (PAS AIR)
WARM AIR
12-93-25
830168-2772

NOTES

i. Air mixers

(1) One air mixer is located on the canopy frame at the forward upper corner of each canopy side window.

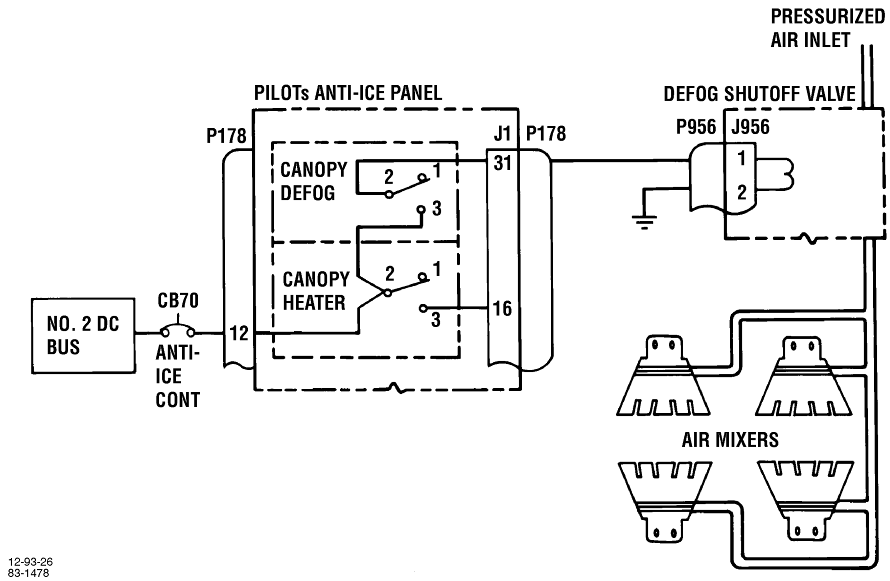
(2) Each air mixer is a tube with small jets, a mixing chamber, and a diffuser.

(3) Hot air from the PAS enters the inlet tubes, via air distribution tubing.

(4) The hot air is routed from the inlet tube to small jets where it creates a low pressure area in the mixing chamber. This low pressure area causes crewstation conditioned air to be drawn into the mixing chamber where it is mixed with the hot air for partial cooling.

(5) The air is then directed though the diffuser against the four (4) canopy side panels. This prevents fogging.

DEFOG SYSTEM ELECTRICAL DIAGRAM



NOTES

j. Defog system operation

(1) When the canopy DEFOG control switch is placed in the ON position, contacts 2 and 3 close.

(2) 28 VDC from the No. 2 DC Bus is applied to P178 pin 12 via CB70. From pin 12, through contacts 3 and 2 of the canopy defog switch to J1 pin 31 of P178, on to P956 and J956 pin 1 in the defog shutoff valve, and out J956 pin 2 to ground.

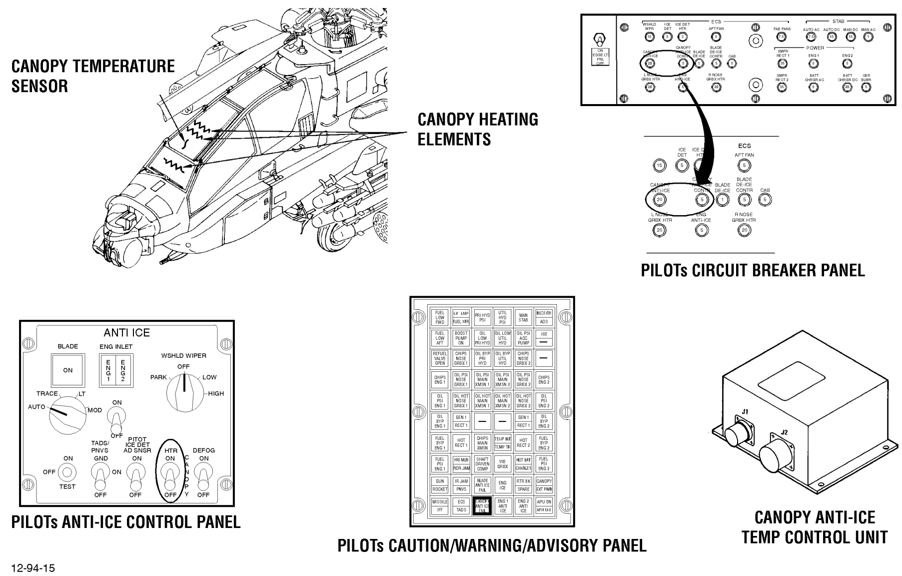
(3) This causes the defog shutoff valve to energize and open.

(4) Hot air flows through the defog valve to the air mixers.

(5) The air mixers mix hot pressurized air with crewstation conditioned air inside the air mixers.

(6) The partially cooled air is directed out of the air mixers against the canopy side panels, defogging them.

CANOPY ANTI-ICE SYSTEM MAJOR COMPONENTS



NOTES

5. Canopy anti-ice system

    a. Prevents ice from forming on the pilot and CPG canopy panels.

    b. Operation controlled only by the pilot.

    c. When activated, provides automatic canopy anti-icing.

    d. Major components

        (1) Canopy HTR control switch

        (2) Canopy anti-ice temperature control unit

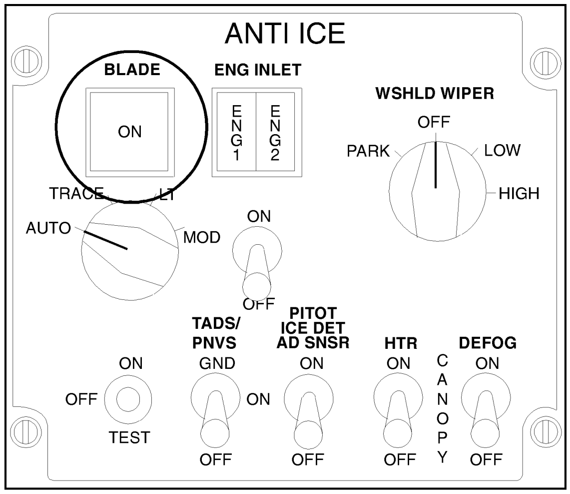
        (3) Canopy temperature sensor

        (4) Canopy anti-ice fail caution light

        (5) Canopy heating elements

        (6) Canopy anti-ice system circuit breakers

PILOTs ANTI-ICE CONTROL PANEL



12-93-47
83-1467

NOTES

e. Canopy heater control switch

(1) Allows the pilot to control operation of the canopy anti-ice system.

(2) Located on the ANTI-ICE control panel in the pilot's left console.

(3) Single-pole, double-throw, two-position toggle switch.

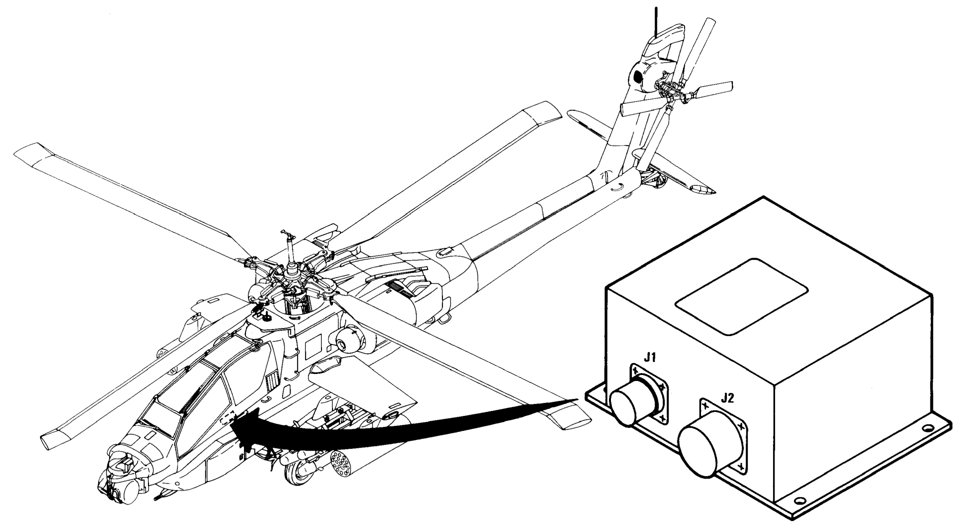
(4) Operation

(a) ON position applies 28 VDC control power to the canopy anti-ice temperature control unit and energizes the canopy anti-ice system.

(b) OFF position removes 28 VDC from the canopy anti-ice control unit and de-energizes the canopy anti-ice system.

071-6

CANOPY ANTI-ICE TEMP CONTROL UNIT



12-92-12

NOTES

f. Canopy anti-ice temperature control unit

(1) When energized, monitors and controls canopy temperature.

(2) Illuminates the CANOPY ANTI-ICE FAIL light on the pilot's caution/warning/advisory (C/W/A) panel if any one of the following failures occur.

(a) Heating element (open or short)

(b) Temperature sensor (open or short)

(c) Input power failure (AC or DC)

(d) Canopy anti-ice temperature control unit failure

(e) Canopy over-temperature above (95EF [35EC])

(3) Located in the CPG's left console beneath the recorder control panel.

(4) Compact, lightweight (2.2 pounds [1 kilogram]), solid-state LRU with two (2) connector receptacles for power and control connections.

(5) Powered by 28 VDC control power from the No. 1 DC Bus, via the HTR ON-OFF switch and three-phase, 115/200 VAC heating element power from the No. 2 AC Bus.

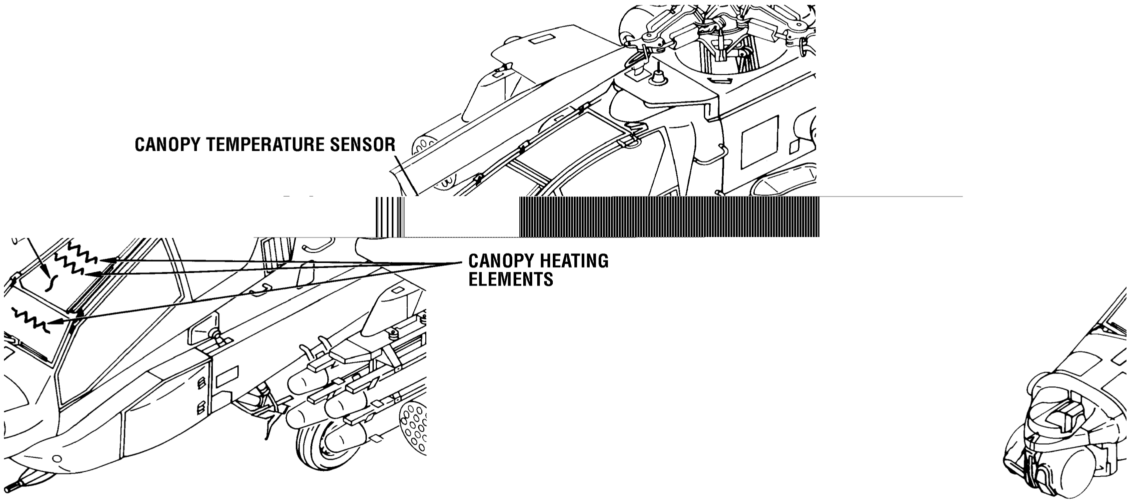
(6) Operation

(a) With both AC and DC power applied, the control unit monitors the canopy temperature sensor resistance and control the application of three-phase, 115/200 VAC heater power to maintain canopy temperature between 65EF and 85EF (13EC and 29EC).

(b) If the canopy overheats or the temperature sensor fails, the control unit disconnects AC power from the heaters.

(c) Power may be reconnected by cycling the HTR control switch OFF and ON.

CANOPY TEMPERATURE SENSOR AND HEATING ELEMENTS



NOTES

g. Canopy temperature sensor

(1) Monitors canopy temperature and provides a corresponding signal to the canopy anti-ice temperature control unit.

(2) Bonded between the outer and inner plies of the pilot's windshield.

(3) Temperature-sensing element has a positive temperature coefficient (if temperature increases, resistance increases).

(4) Operation

(a) Temperature-sensor is monitored by the control unit.

(b) As windshield temperature rises, resistance rises to 323 " 3 ohms at 85EF (29EC).

(c) As windshield temperature decreases, resistance decreases to 310 "3 ohms at 65EF (13EC)

h. Canopy heating elements

Prevent ice formation on the pilot and CPG crewstation windshields.

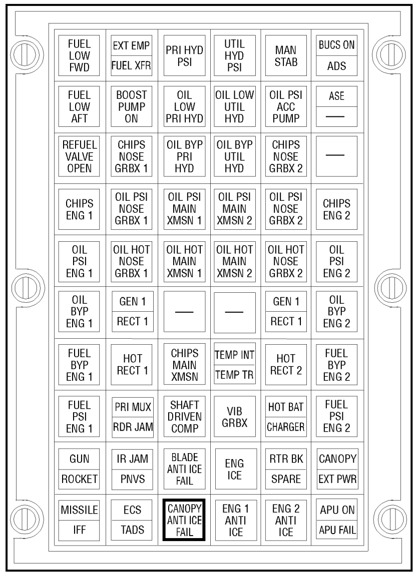
(1) Two (2) heating elements are bonded between the inner and outer plies of the pilot's windshield.

(2) One (1) heating element is bonded between the inner and outer plies of the CPG's windshield.

(3) All three (3) metallic heating elements are joined together in a three-phase, 115/200 VAC delta connection. (A delta connection is a method of joining the three heating elements so that the maximum current, and therefore heat energy, is applied to each element with the available voltage.)

(4) The heating elements are placed so as to provide uniform windshield heating.

CANOPY ANTI-ICE FAIL CAUTION LIGHT



12-93-28
83-1471

PILOTs CAUTION/WARNING/ADVISORY PANEL

NOTES

i. Canopy anti-ice fail caution light

(1) Alerts the pilot to a failure in the canopy anti-ice system.

(2) Located on the pilot's C/W/A panel.

(3) Amber-colored light.

(4) Illuminates if any one of the following failures occur.

(a) Heating element (open or short)

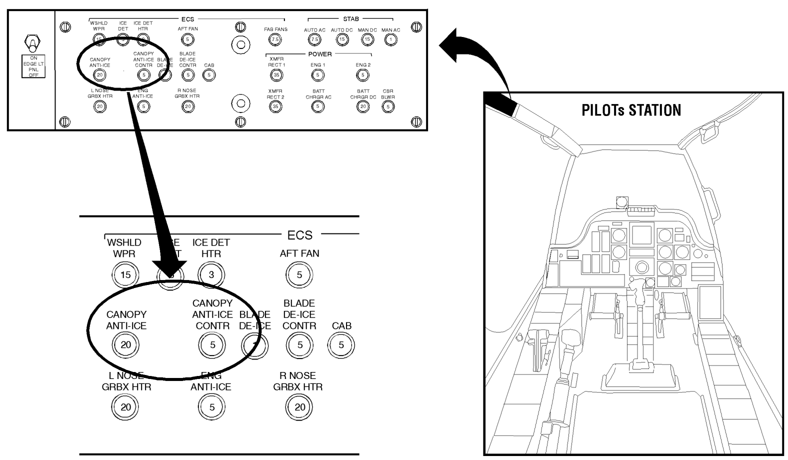
(b) Temperature sensor (open or short)

(c) Input power (AC or DC)

(d) Canopy anti-ice temperature control unit.

(e) Canopy over-temperature [above 95EF (35EC)]

CANOPY ANTI-ICE SYSTEM CIRCUIT BREAKERS



12-93-29
86-99

NOTES

j. Canopy anti-ice system circuit breakers

(1) CANOPY ANTI-ICE CONTR (CB70)

(a) Provides DC circuit protection for the canopy anti-ice system.

(b) Located on the pilot's aft overhead circuit breaker panel.

(c) Rated at 28 VDC and 5 amperes.

(d) Powered by the No. 1 DC Bus.

(e) Supplies control power for the canopy anti-ice temperature control unit.

(2) CANOPY ANTI-ICE (CB78)

(a) Provides AC circuit protection for the canopy anti-ice system.

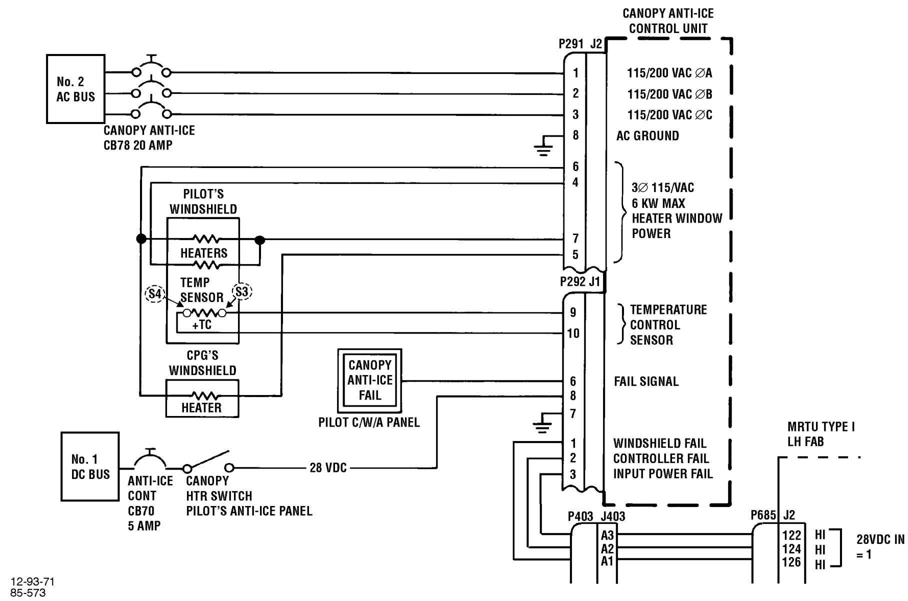
(b) Located on the pilot's aft overhead circuit breaker panel.

(c) Three-phase, ganged circuit breaker rated 115/200 VAC and 20 amps.

(d) Powered by the No. 2 AC bus.

(e) Supplies heater power for the canopy anti-ice system.

CANOPY ANTI-ICE SCHEMATIC



NOTES

k. Canopy anti-ice system operation

(1) Three-phase, 115/200 VAC power is applied to the canopy anti-ice temperature control unit via P291-1, P291-2, and P291-3 from the CANOPY ANTI-ICE circuit breaker (CB78).

(2) 28 VDC is applied to the canopy HTR ON-OFF switch via the canopy ANTI-ICE CONTR circuit breaker (CB70).

(3) In the ON position, the HTR control switch applies 28 VDC to the canopy anti-ice control unit, via P292-8.

(4) If canopy temperature is below 65EF (13EC), the canopy anti-ice control unit, though P291-4, 5, 6, 7 applies three-phase 115/200 VAC 6 Kilowatt (KW) power to the three-phase canopy heater.

(5) The canopy begins to heat.

(6) The temperature sensor is monitored by the canopy anti-ice control unit via a signal sent from the temperature sensor, via P292-9, 10. The canopy anti-ice control unit then regulates the three-phase power applied to the heaters. This keeps the canopy temperature between 65EF (13EC) and 85EF (29EC).

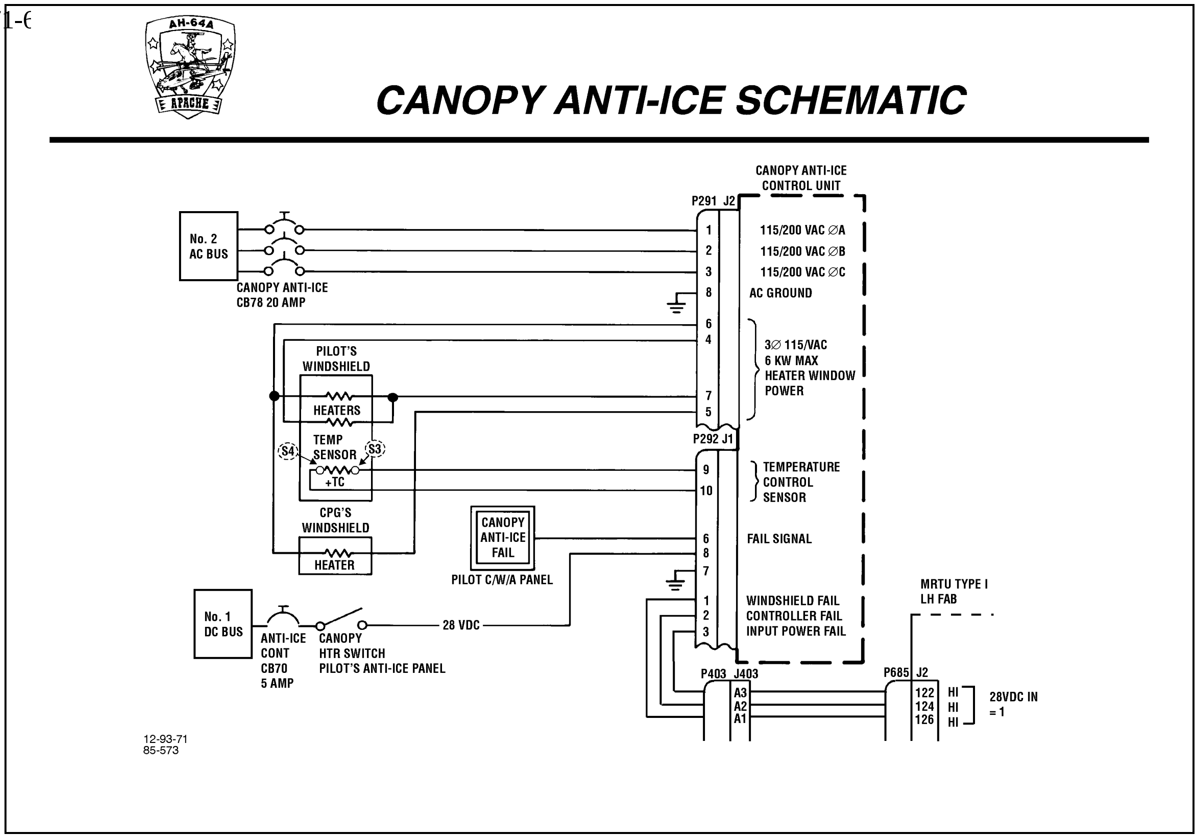
(7) If the control unit, canopy heater(s), canopy temperature sensor, or input power fails, or if the canopy overheats, the control unit illuminates the CANOPY ANTI-ICE FAIL light on the pilot's C/W/A panel.

(8) If the windshield heater should fail, a low-power 28 VDC signal is sent via P292-1 though the CPG crossover disconnect P403 and out J403 A1 into P685 and into J2 126 into an MRTU Type I, in the left FAB. The MRTU sends a windshield heater GO/NO-GO signal to the fire control computer (FCC) for use with the maintenance fault detection location system (FD/LS).

(9) If the control unit should fail, a low-power 28 VDC signal is sent via P292-2 though the CPG crossover disconnect P403, out J403 A2 into P685, and into J2 124 on in to the MRTU. The MRTU sends the signal to the FCC providing a NO-GO signal for use with the maintenance FD/LS.

(10) If the input power should fail, a low-power 28 VDC signal is sent via P292-3 though the CPG crossover disconnect P403, out J403 A3 into P685, and into J2 122 on in to the MRTU. The MRTU sends an input power NO-GO fail signal to the FCC for use with the maintenance FD/LS.

(11) Canopy overheating or temperature sensor failure (open or shorted) causes the control unit to disconnect heater power.


AH-64A
APACHE
CANOPY ANTI-ICE SCHEMATIC
CANOPY ANTI-ICE
CONTROL UNIT
P291 J2
No. 2
AC BUS
CANOPY ANTI-ICE
CB78 20 AMP
115/200 VAC ∅A
115/200 VAC ∅B
115/200 VAC ∅C
AC GROUND
3∅ 115/VAC
6 KW MAX
HEATER WINDOW
POWER
PILOT'S
WINDSHIELD
HEATERS
TEMP
SENSOR
S4
S3
+TC
P292 J1
TEMPERATURE
CONTROL
SENSOR
CPG'S
WINDSHIELD
HEATER
CANOPY
ANTI-ICE
FAIL
PILOT C/W/A PANEL
FAIL SIGNAL
No. 1
DC BUS
ANTI-ICE
CONT
CB70
5 AMP
CANOPY
HTR SWITCH
PILOT'S ANTI-ICE PANEL
28 VDC
WINDSHIELD FAIL
CONTROLLER FAIL
INPUT POWER FAIL
MRTU TYPE I
LH FAB
P403 J403
P685 J2
A3
A2
A1
122
124
126
HI
HI
HI
28VDC IN
= 1
12-93-71
85-573

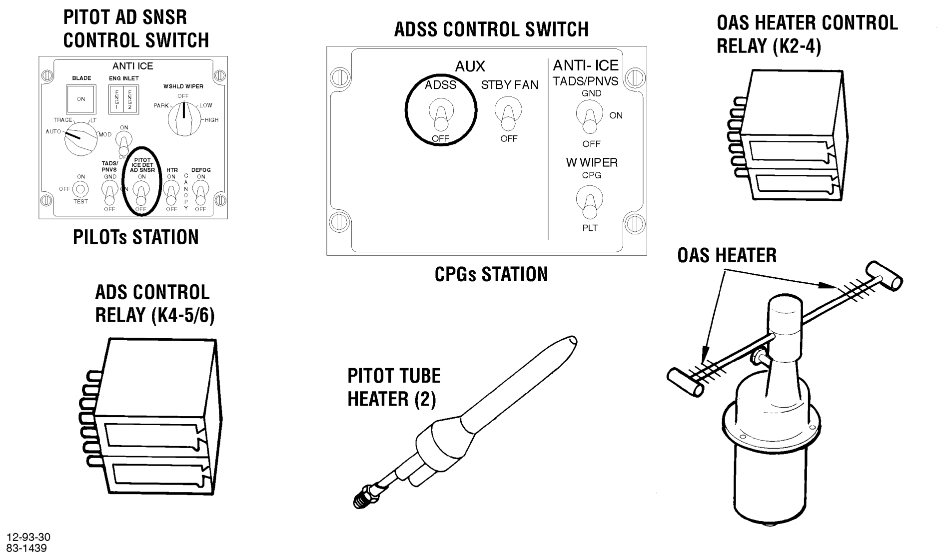
NOTES

(12) The control unit latches in the OFF condition, and may be recycled by turning the HTR control OFF, then ON.

(a) If the fault was temporary, the control unit re-energizes and apply heater power.

(b) If the fault still exists, the control unit trips again.

PITOT AND AIR DATA SENSOR ANTI-ICE SYSTEM MAJOR COMPONENTS



NOTES

A. Anti-ice and deice systems

1. Pitot and air data sensor anti-ice system

a. Prevents ice from forming on the pitot tubes and omnidirectional airspeed sensor (OAS).

b. Components

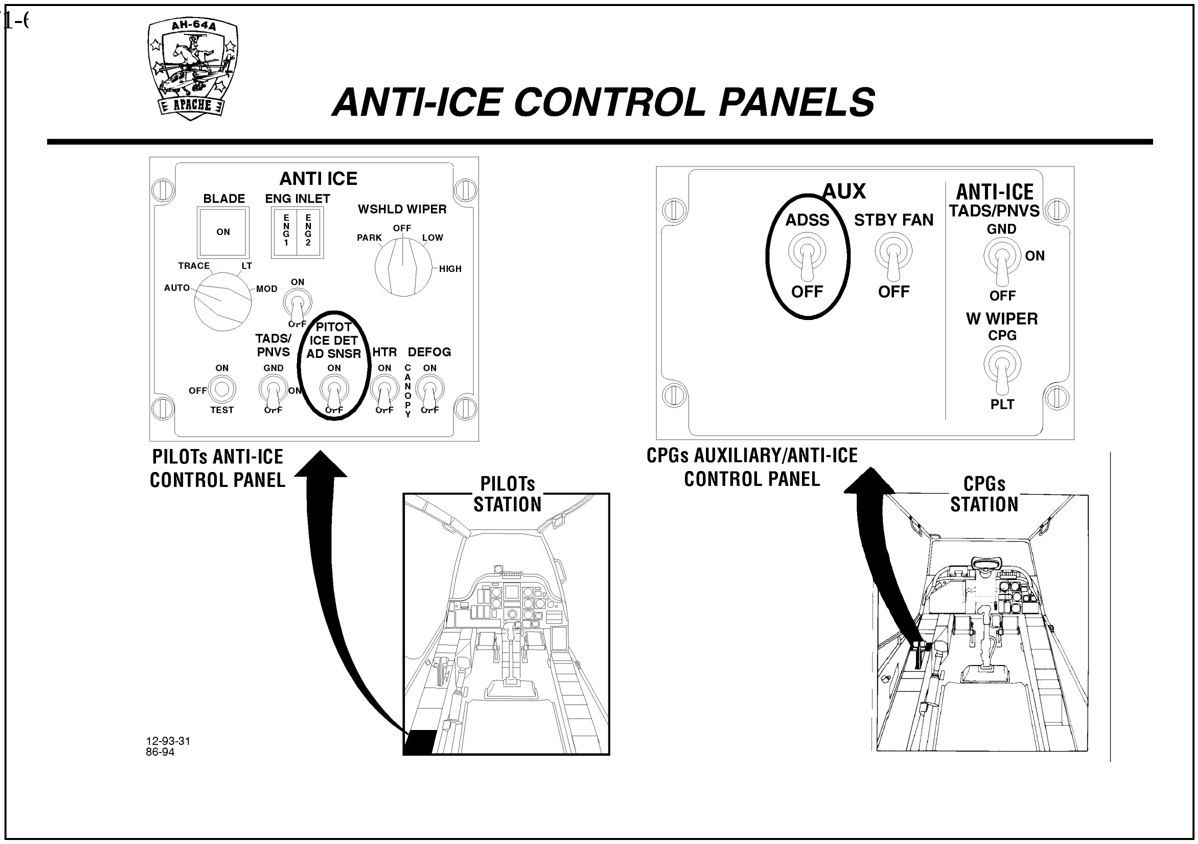
(1) PITOT/ICE DET/AD SNSR control switch

(2) ADSS control switch

(3) OAS heater control relay (K2-4)

(4) ADS control relay (K4-5/6)

(5) Pitot tube heaters (2)


AH-64A
APACHE
ANTI-ICE CONTROL PANELS
ANTI ICE
BLADE
ON
ENG INLET
ENG 1
ENG 2
WSHLD WIPER
OFF
PARK
LOW
HIGH
TRACE
LT
AUTO
MOD
ON
OFF
TADS/PNVS
PITOT ICE DET AD SNSR
HTR
DEFOG
ON
GND
ON
ON
ON
OFF
TEST
OFF
OFF
OFF
OFF
CANOPY
AUX
ADSS
STBY FAN
OFF
OFF
ANTI-ICE
TADS/PNVS
GND
ON
OFF
W WIPER
CPG
PLT
PILOTs ANTI-ICE CONTROL PANEL
PILOTs STATION
CPGs AUXILIARY/ANTI-ICE CONTROL PANEL
CPGs STATION
12-93-31
86-94

NOTES

c. Anti-ice control panels

(1) PITOT/ICE DET/AD SNSR control switch

(a) Allows the pilot to control left and right pitot heater operation.

(b) Controls 28 VDC to the coil of the OAS HTR CONT RLY.

(c) Controls 28 VDC to the rotor blade ice detector relay.

(d) Located on the ANTI-ICE control panel in the pilot's left console.

(e) Double-pole, double-throw, two-position toggle switch.

(f) Powered by 28 VDC from the emergency DC Bus via the PITOT HTR circuit breaker (CB36).

(g) Operation

1) OFF position de-energizes the pitot, air data system (ADS), and ice detector anti-ice systems.

2) ON position supplies 28 VDC to:

a) The left and right pitot tube heaters.

b) The coil of the OAS HTR CONT RLY.

c) The coil of the ice detector deice sensor air shutoff valve.

NOTE: Operation of the ICE DET function is discussed later in this lesson.

d. Air data subsystem (ADSS) control switch

(1) Controls operation of the ADS CONT RLY.

(2) Located on AUX/ANTI-ICE control panel in the CPG's left console.

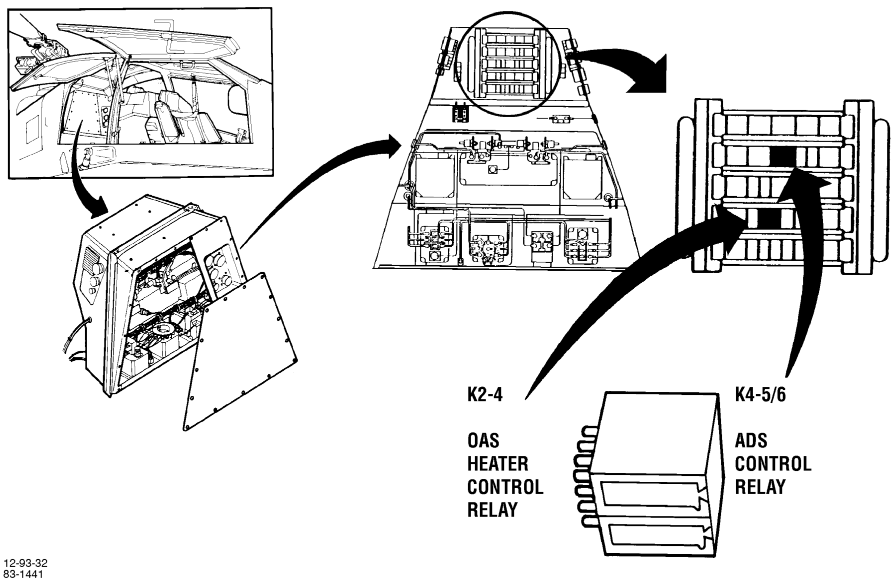
(3) Single-pole, double-throw, two-position toggle switch.

(4) Operation

(a) OFF position removes the ground from the coil of the ADS CONT RLY, causing the relay to de-energize.

(b) ON position supplies a ground to the coil to energize the ADS CONT RLY.

OAS HEATER AND ADS CONTROL RELAYS



NOTES

e. OAS heater control relay

(1) Controls single-phase, 115/200 VAC, 400 Hz heater power to the OAS heater.

(2) Located in the electrical power distribution center behind the pilot's seat.

(3) Small [1 x 1 x 1 inch (2.5 x 2.5 x 2.5 centimeters)], lightweight [1.4 ounce (39.6 grams)] LRU.

(4) Energized by 28 VDC from the No. 3 DC Bus via the pilot's PITOT AD SENSOR switch.

f. ADS control relay (K4-5/6)

(1) Controls

(a) 28 VDC power to the air data processor.

(b) Three-phase, 115/200 VAC, 400 Hz motor drive power to the OAS sensor.

(c) Single-phase, 115/200 VAC, 400 Hz OAS heater power to the OAS HTR CONT RLY.

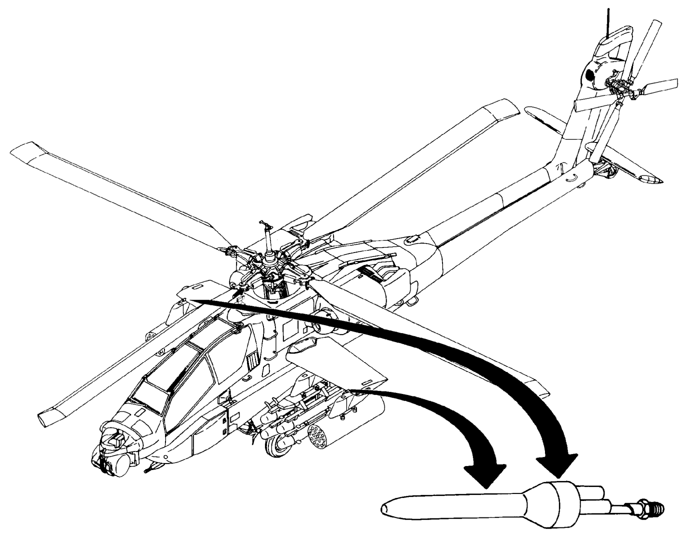
(2) Located in the electrical power distribution center behind the pilot's seat.

(3) Small [1 x 1 x 1 inch (2.5 x 2.5 x 2.5 centimeters)], lightweight [1.4 ounce (39.6 grams)] LRU.

(4) Coil connected directly to 28 VDC from the No. 3 DC Bus via the AIR DATA DC circuit breaker (CB69).

(5) Coil ground is controlled by the ADSS control switch.

PITOT TUBES



12-92-10

NOTES

WARNING

HIGH TEMPERATURE

All ground handling personnel must be informed of high temperature hazards when working near pitot tubes.

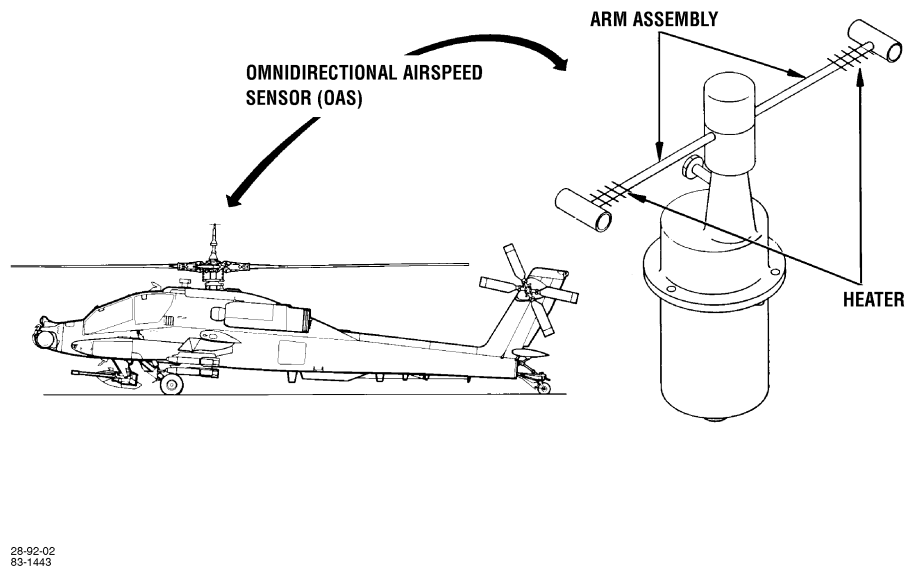
g. Pitot tube heaters

(1) Prevent ice from forming on the right (pilot) and left (CPG) pitot tubes.

(2) Located inside the pitot tubes on the left and right wings.

(3) 28 VDC resistive wire heating element.

OMNIDIRECTIONAL AIRSPEED SENSOR (OAS)



NOTES

h. OAS heater

(1) Prevents ice from forming on the OAS.

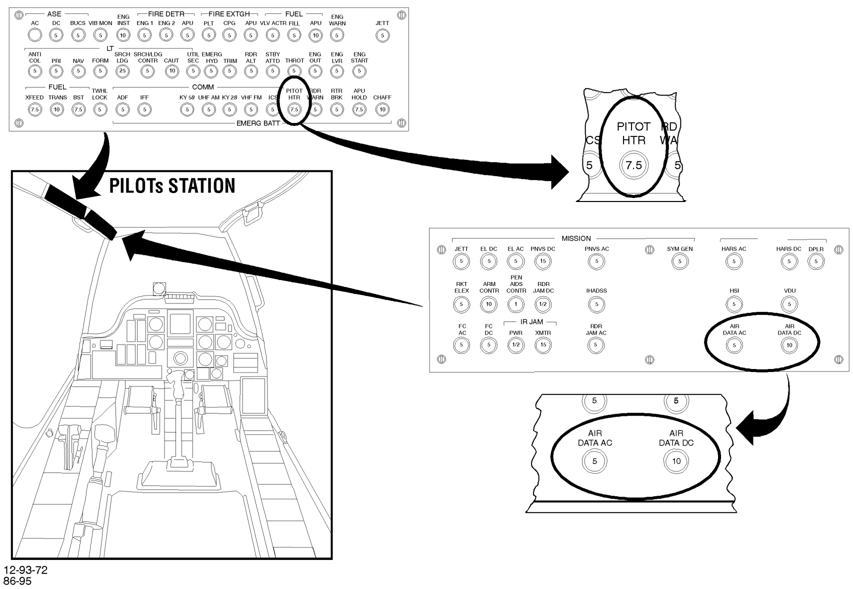
(2) Located on the OAS arm assembly.

(3) Single-phase, 115/200 VAC, resistive wire heating element.

(4) Wrapped externally on the OAS arm assembly.

(5) Covered by a protective sleeve.

PITOT AND AIR DATA SENSOR ANTI-ICE SYSTEM CIRCUIT BREAKERS



NOTES

i. PITOT HTR circuit breaker

(1) Provides DC circuit protection for the right (pilot's) pitot tube heater.

(2) Located on the pilot's center overhead circuit breaker panel.

(3) Rated at 28 VDC and 7.5 amperes.

(4) Powered by the emergency DC Bus.

(5) Supplies 28 VDC for the pilot's pitot tube heater.

j. AIR DATA DC circuit breaker

(1) Provides circuit protection and 28 VDC for the following components.

(a) Air data processor

(b) Left (CPG's) pitot tube heater

(c) ADS control relay

(d) OAS heater control relay

(2) Located on the pilot's forward overhead circuit breaker panel.

(3) Rated at 28 VDC and 10 amperes.

(4) Powered by the No. 3 DC Bus.

k. AIR DATA AC circuit breaker

(1) Provides AC circuit protection for the OAS heater and motor drive circuits.

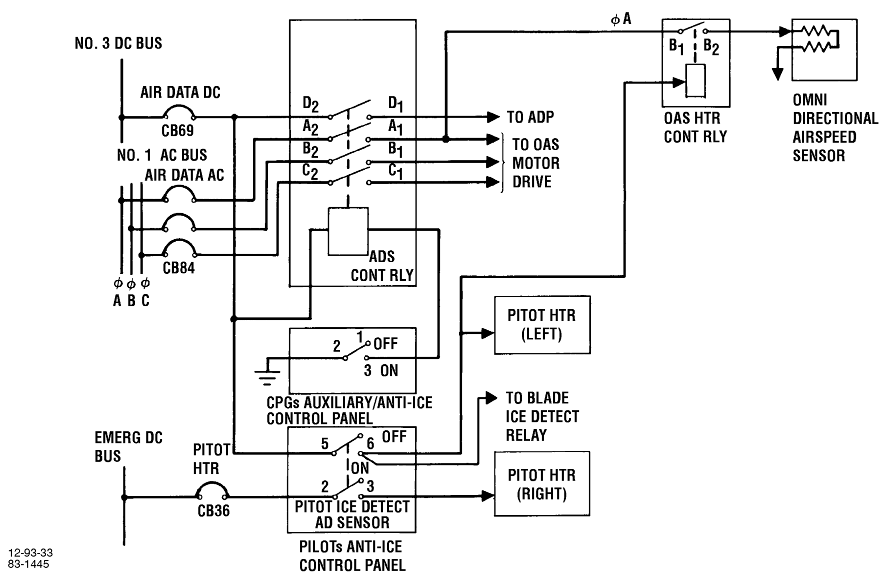
(2) Located on the pilot's forward overhead circuit breaker panel.

(3) Ganged, three-phase, 115/200 VAC, 5 ampere circuit breaker.

(4) Powered by the No. 1 AC Bus.

(5) Supplies single-phase 115/200 VAC for the OAS heater, and three-phase, 115/200 VAC for the OAS motor drive.

PITOT AND AD SENSOR ANTI-ICE OPERATION



NOTES

l. Pitot heater operation

(1) With the pilot's PITOT/ICE DET/AD SNSR switch placed in the ON position:

(a) 28 VDC from the emergency DC Bus via the PITOT HTR (CB36) is routed through contacts 2 and 3 to the pilot's pitot tube heater.

(b) 28 VDC from the No. 3 DC Bus via the AIR DATA DC (CB69) is routed through contacts 5 and 6 to the CPG's pitot tube heater, and the coil of the OAS heater control relay.

(c) In the event of a DC electrical system failure, only the pilot's pitot tube heater receives emergency DC Bus power.

(2) This causes both pitot tube heaters to heat, and the OAS heater control relay to energize.

m. OAS heater operation

(1) With the OAS heater control relay energized, contacts B1 and B2 are connected together.

(2) In order to apply AC heater power to the OAS heater, the ADS control relay must be energized.

(3) To energize the ADS control relay, 28 VDC from the No. 3 DC Bus via the AIR DATA DC CB69 is connected to the coil of the ADS control relay.

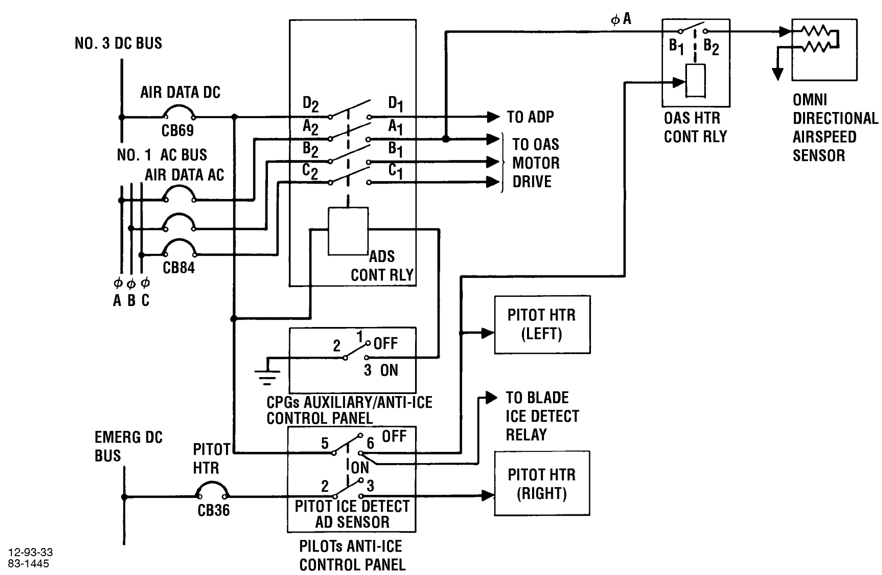
(4) When the CPG's ADSS control switch is placed in the ON position, a ground is applied through contacts 2 and 3 to the ADS control relay.

(5) This causes the ADS control relay to energize and route 115/200 VAC, phase A from the No. 1 AC Bus through the AIR DATA AC CB84, through contacts A2 and A1 to contact B1 of the OAS heater control relay.

(6) The OAS heater control relay routes the AC power through contacts B1 and B2 to the OAS Heater.

(7) When the pilot's PITOT ICE DETECT AD SENSOR switch is placed in the ON position:

PITOT AND AD SENSOR ANTI-ICE OPERATION

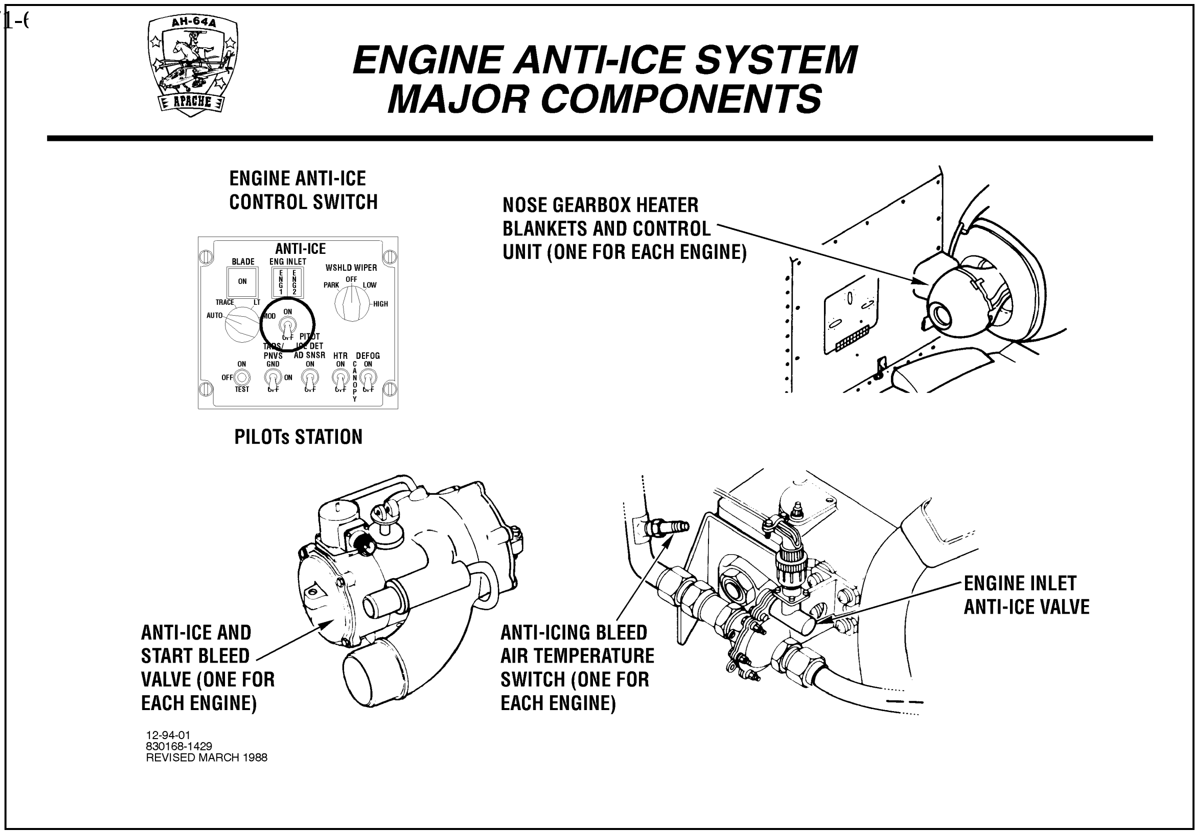


NOTES

(a) 28 VDC is applied to the OAS heater control, energizing it.

(b) 115/200 VAC phase A power from the ADS control relay is applied to the heating elements.

(8) System heater power is applied as long as both the PITOT AD SENSR and ADSS switches are in the ON position.


AH-64A
APACHE
ENGINE ANTI-ICE SYSTEM
MAJOR COMPONENTS
ENGINE ANTI-ICE
CONTROL SWITCH
ANTI-ICE
BLADE
ENG INLET
WSHLD WIPER
PARK
OFF
LOW
HIGH
TRACE
AUTO
PITOT
PNVS
AD SNSR
HTR
DEFOG
TEST
PILOTs STATION
NOSE GEARBOX HEATER
BLANKETS AND CONTROL
UNIT (ONE FOR EACH ENGINE)
ANTI-ICE AND
START BLEED
VALVE (ONE FOR
EACH ENGINE)
ANTI-ICING BLEED
AIR TEMPERATURE
SWITCH (ONE FOR
EACH ENGINE)
ENGINE INLET
ANTI-ICE VALVE
12-94-01
830168-1429
REVISED MARCH 1988

NOTES

B. Engine anti-ice system

1. Engine anti-ice major components

   a. Engine anti-ice control switch

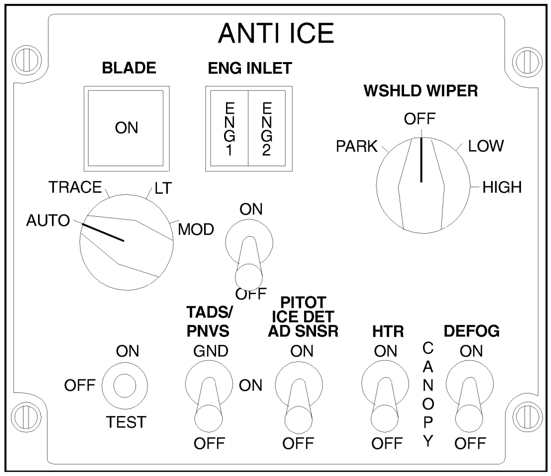
   b. Nose gearbox (NGB) heater blanket and control unit (one for each NGB)

   c. Engine anti-ice and start bleed valve (one for each engine)

   d. Engine inlet anti-ice valve (one for each engine)

   e. Anti-ice bleed air temperature switch (one for each engine inlet anti-ice valve)

PILOTs ANTI-ICE CONTROL PANEL



12-94-14
83-1469

NOTES

2. Engine anti-ice control switch

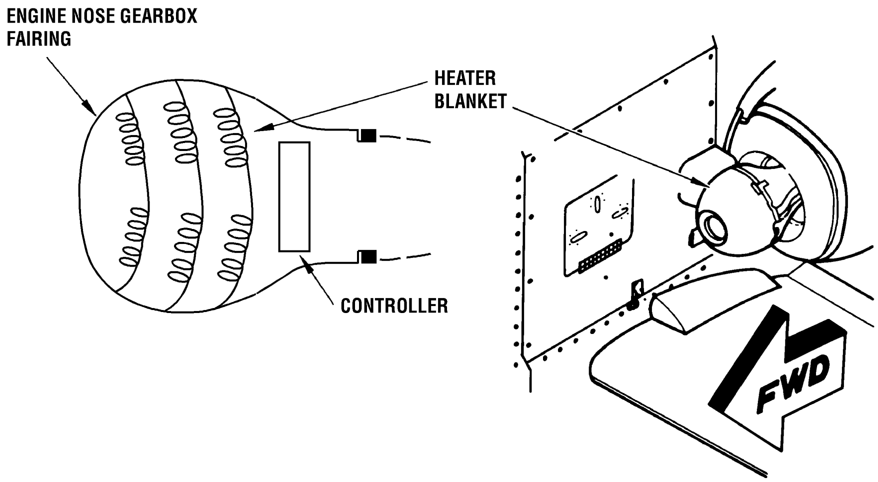
   a. The switch is a single-pole, double-throw toggle switch. It allows the pilot to turn the engine anti-ice system on or off. The CPG has no control of the engine anti-ice system.

   b. Controls are located on left side of pilot's console. The engine anti-ice switch is the center switch in the control panel.

   c. When the anti-ice switch is placed in the OFF position, 28 vdc is routed to the engine anti-ice/start bleed valve and to the engine inlet anti-ice valve, energizing the valves to a closed position.

   d. Placing the anti-ice switch to ON removes the 28 vdc input, opening the valves. At the same time 28 vdc is routed to the engine nose gearbox heater control units supplying operational voltage to the heater blankets.

ENGINE NOSE GEARBOX FAIRING ANTI-ICE



12-94-02
83-1431

NOTES

3. NGB heater blanket and controller unit

   a. Prevents ice buildup around the NGB fairing.

   b. Heater blanket

      (1) An integral part of the forward and upper aft NGB fairings.

      (2) Heater elements are three-phase AC heater coils requiring 115/200 VAC 400 Hz power for operation.

   c. The controller unit

      (1) An integral part of the forward NGB fairing.

      (2) Consists of a control sensor and a safety sensor.

      (3) Non-repairable unit.

   d. Operation

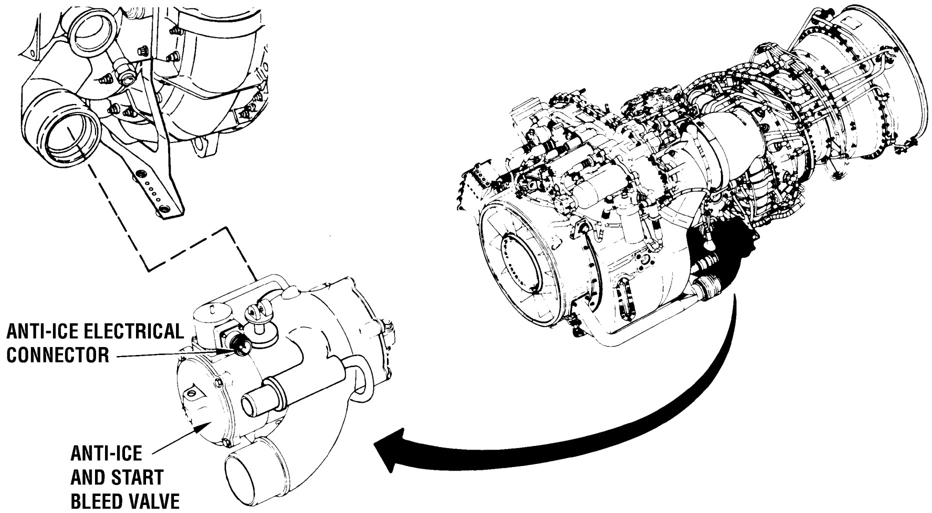
      (1) The control unit is energized by the Engine anti-ice control switch.

      (2) When the system is energized, the control unit controls the application of three-phase 115/200 VAC to the heater blankets to maintain the NGB fairings temperature between 225EF and 235EF (107EC and 113EC).

      (3) If the NGB fairing overheats, the safety sensor causes the caution light on the C/W/A panels (pilot's and CPG's) to illuminate and the heater blanket to deactivate.

      (4) If the control sensor or the safety sensor should become shorted or opened, the unit deactivates the blanket and illuminates the caution lights.

ENGINE ANTI-ICE AND START BLEED VALVE



12-94-03
83-1432A

NOTES

4. Engine anti-ice and start bleed valve

    a. Controls anti-icing airflow to the engine and bleeds air from the compressor during start and low engine speed.

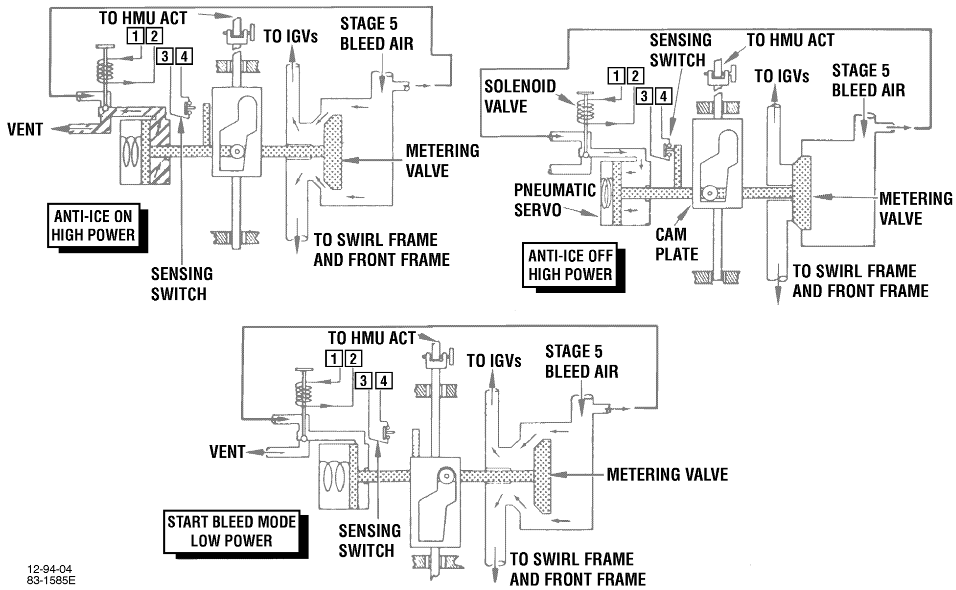
    b. Mounted on the compressor stator (cold seat module), lower left outboard side of the No. 1 engine and lower left inboard side of the No. 2 engine.

    c. Valve is spring-loaded open (fail safe on).

    d. Controlled mechanically by the variable geometry (VG) actuator on the HMU.

    e. 28 VDC must be applied to the valve solenoid to energize the valve to the closed position.

ANTI-ICE AND START BLEED VALVE OPERATION



NOTES

f. Operation

(1) Mechanical

(a) During start or at low engine rpm, the HMU positions a cam plate that mechanically opens the metering valve. This action overrides any action of the pneumatic servo.

(b) At engine speeds above 91% N_G or 60% torque, whichever occurs first, the HMU positions the cam plate to allow the pneumatic servo to open or close the metering valve. The valve opens or closes depending upon cockpit switch selection.

(2) Electrical

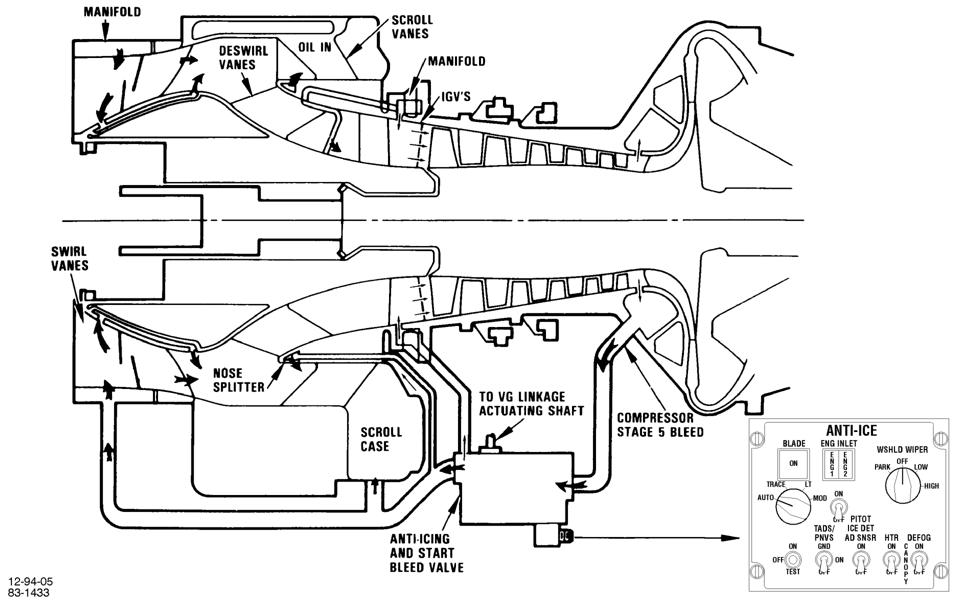
(a) Energizing (anti-ice off) the solenoid open blocks the pneumatic servo from venting. Fifth stage bleed air forces the metering valve to the closed position, overriding the servo spring pressure.

(b) De-energizing (anti-ice on) the solenoid closed vents the pneumatic servo. Spring pressure forces the metering valve open routing fifth stage bleed air to the inlet guide vanes.

(c) If electrical power is lost the solenoid valve automatically goes to the open position.

(d) Should the solenoid fail to open when energized, the metering valve shaft is off the sensing switch, the ENGINE 1 and ENGINE 2 green advisory lights illuminate.

ENGINE ANTI-ICE



NOTES

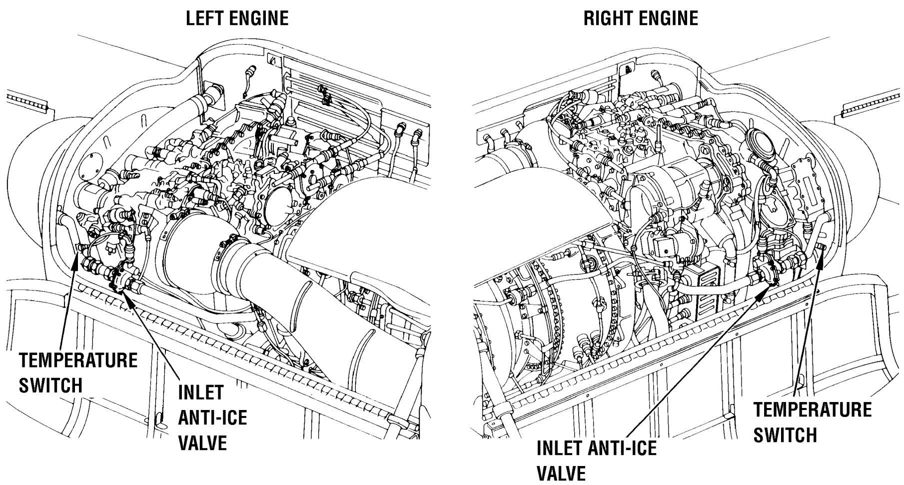
5. Engine anti-ice

   a. Prevents damage to the engines when the aircraft is flown in visible moisture with temperatures less than 5EC (41EF).

   b. System is controlled by a two-position switch located on the pilot's anti-ice control panel.

   c. Engine anti-icing is accomplished through the use of fifth stage bleed air. The heated air heats the engine guide vanes, swirl vanes, and de-swirl vanes.

ENGINE INLET ANTI-ICE VALVE LOCATION



12-94-06
83-1434B

NOTES

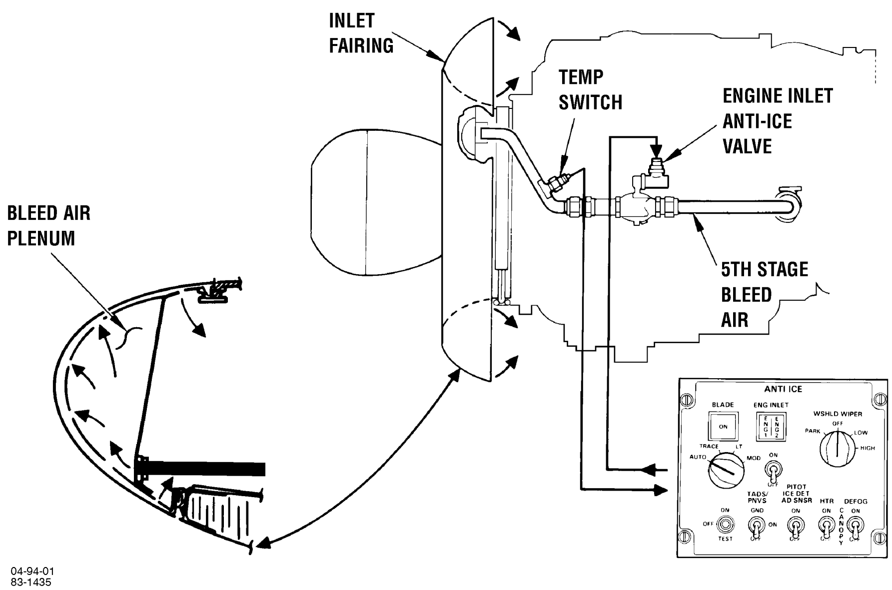
6. Engine inlet anti-ice valve and anti-icing bleed air temperature switch

   a. The valve controls anti-icing airflow to the engine inlet fairings. The temperature switch senses the temperature of the air going from the anti-ice valve to the inlet fairing.

   b. An anti-ice valve is located on the outboard side of each engine on the main frame cold section. A temperature switch is mounted in the bleed air tube between the inlet anti-ice valve and engine inlet fairing on each engine.

   c. The anti-ice valve is an electrically controlled, spring-loaded open pneumatic valve. The temperature switch is normally open and responds to temperature changes within 40 seconds or less.

ENGINE INLET ANTI-ICE



NOTES

d. Operation

(1) Anti-ice valve

(a) Placing the anti-ice control switch in the OFF position applies 28 VDC to the valve solenoid. This energizes the valve closed.

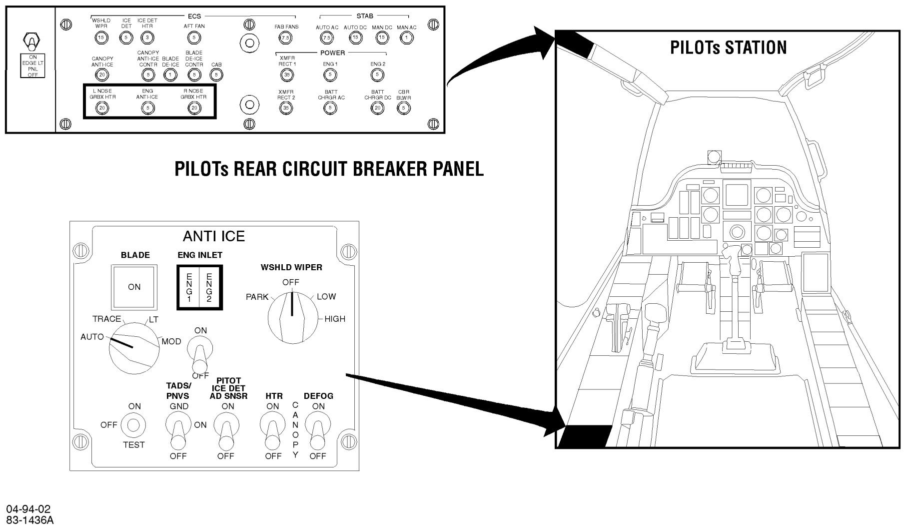
(b) Placing the switch to the ON position removes electrical power. This allows the valve to open and supply bleed air to the inlet fairing.

(2) Temperature switch

(a) Normally open and continuously senses temperature of the airflow.

(b) Closes when air temperature reaches 155E " 5EF (68E " 1.5EC).

ENGINE ANTI-ICE CIRCUIT BREAKER AND CONTROL PANEL



NOTES

7. Anti-ice system circuit protection

a. Engine anti-ice (ENG ANTI-ICE) circuit breaker (CB67)

(1) Provides circuit protection for the anti-ice system.

(2) Located in the pilot's aft circuit breaker panel.

(3) System uses a 5-ampere, thermally actuated DC circuit breaker.

(4) If the current through the circuit breaker exceeds 5-amperes the CB opens, removing electrical power from the engine anti-ice system.

b. Left and right nose gearbox heater (L NOSE GRBX HTR AND R NOSE GRBX HTR) circuit breakers (CB38 and CB211)

(1) Provide protection for the No. 1 and No. 2 NGB heater blankets.

(2) Located in the pilot's aft circuit breaker panel.

(3) System uses 20-ampere, three-phase, thermally actuated AC circuit breakers.

(4) If the current in any phase exceeds 20-amperes, the affected circuit breaker opens all three phases to the heater blanket.

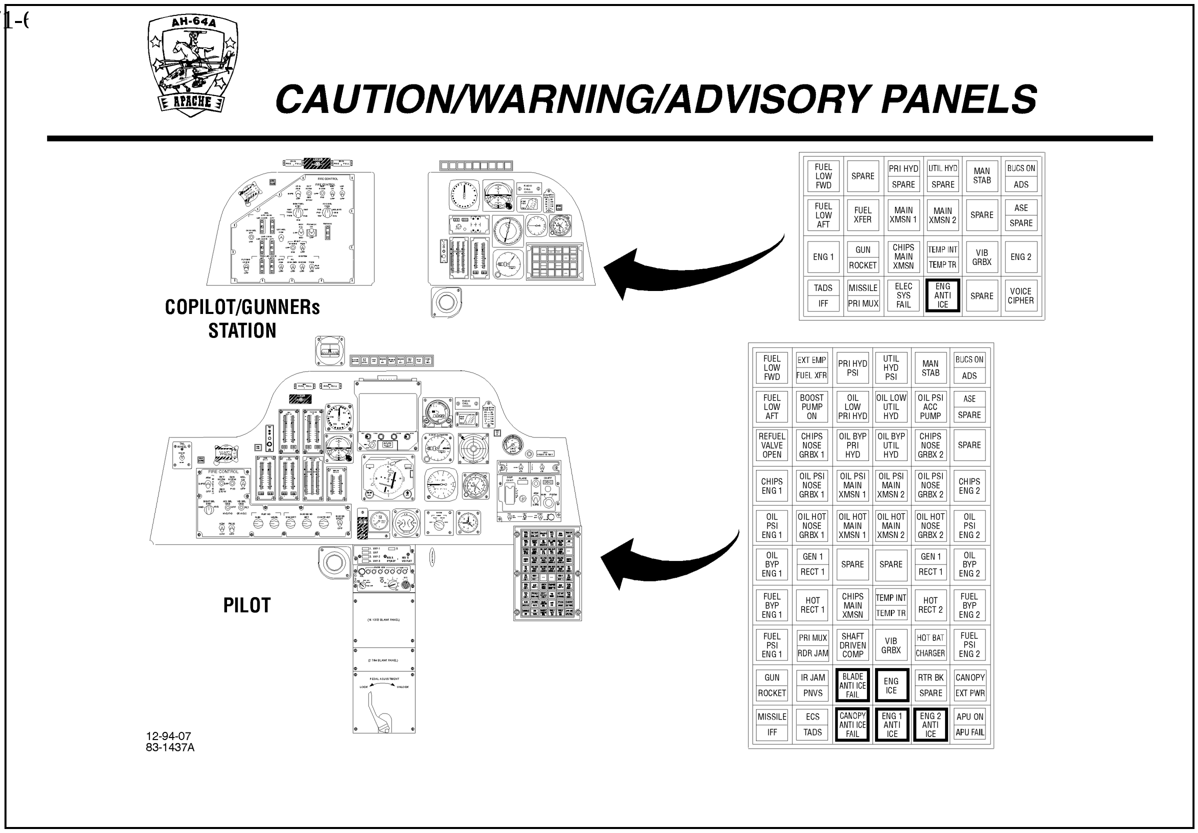
c. Anti-icing indication

ENG 1 and ENG 2 INLET advisory lights

(1) Provide the pilot a visual indication of anti-ice and start bleed valve operation.

(2) The ENG 1 and ENG 2 engine inlet advisory lights are located on the pilot's anti-ice control panel.

(3) Each segment light has two bulbs and illuminates green when the anti-ice and start bleed valve is open.


AH-64A
APACHE
CAUTION/WARNING/ADVISORY PANELS
COPILOT/GUNNERs STATION
PILOT
FUEL LOW FWD | SPARE | PRI HYD / SPARE | UTIL HYD / SPARE | MAN STAB | BUCS ON / ADS
FUEL LOW AFT | FUEL XFER | MAIN XMSN 1 | MAIN XMSN 2 | SPARE | ASE / SPARE
ENG 1 | GUN / ROCKET | CHIPS MAIN XMSN | TEMP INT / TEMP TR | VIB GRBX | ENG 2
TADS / IFF | MISSILE / PRI MUX | ELEC SYS FAIL | ENG ANTI ICE | SPARE | VOICE CIPHER
FUEL LOW FWD | EXT EMP / FUEL XFR | PRI HYD PSI | UTIL HYD PSI | MAN STAB | BUCS ON / ADS
FUEL LOW AFT | BOOST PUMP ON | OIL LOW PRI HYD | OIL LOW UTIL HYD | OIL PSI ACC PUMP | ASE / SPARE
REFUEL VALVE OPEN | CHIPS NOSE GRBX 1 | OIL BYP PRI HYD | OIL BYP UTIL HYD | CHIPS NOSE GRBX 2 | SPARE
CHIPS ENG 1 | OIL PSI NOSE GRBX 1 | OIL PSI MAIN XMSN 1 | OIL PSI MAIN XMSN 2 | OIL PSI NOSE GRBX 2 | CHIPS ENG 2
OIL PSI ENG 1 | OIL HOT NOSE GRBX 1 | OIL HOT MAIN XMSN 1 | OIL HOT MAIN XMSN 2 | OIL HOT NOSE GRBX 2 | OIL PSI ENG 2
OIL BYP ENG 1 | GEN 1 / RECT 1 | SPARE | SPARE | GEN 1 / RECT 1 | OIL BYP ENG 2
FUEL BYP ENG 1 | HOT RECT 1 | CHIPS MAIN XMSN | TEMP INT / TEMP TR | HOT RECT 2 | FUEL BYP ENG 2
FUEL PSI ENG 1 | PRI MUX / RDR JAM | SHAFT DRIVEN COMP | VIB GRBX | HOT BAT / CHARGER | FUEL PSI ENG 2
GUN / ROCKET | IR JAM / PNVS | BLADE ANTI ICE FAIL | ENG ICE | RTR BK / SPARE | CANOPY / EXT PWR
MISSILE / IFF | ECS / TADS | CANOPY ANTI ICE FAIL | ENG 1 ANTI ICE | ENG 2 ANTI ICE | APU ON / APU FAIL
12-94-07
83-1437A

NOTES

d. Anti-ice caution lights

(1) Provide the pilot and CPG a visual indication of anti-ice system malfunctions.

(2) The ENG ICE caution segment light and the ENG 1 and ENG 2 ANTI-ICE caution segment lights are located on the pilot's C/W/A panel. The ENG ANTI-ICE caution segment light is located on the CPG's C/W/A panel.

(3) Each of the anti-ice caution lights occupies a full segment of the C/W/A panel and are amber in color when illuminated.

(4) When the anti-ice switch is placed to the ON position, the ENG 1 and ENG 2 ANTI-ICE lights illuminate until the respective anti-ice bleed air temperature switch senses 155EF (68EC).

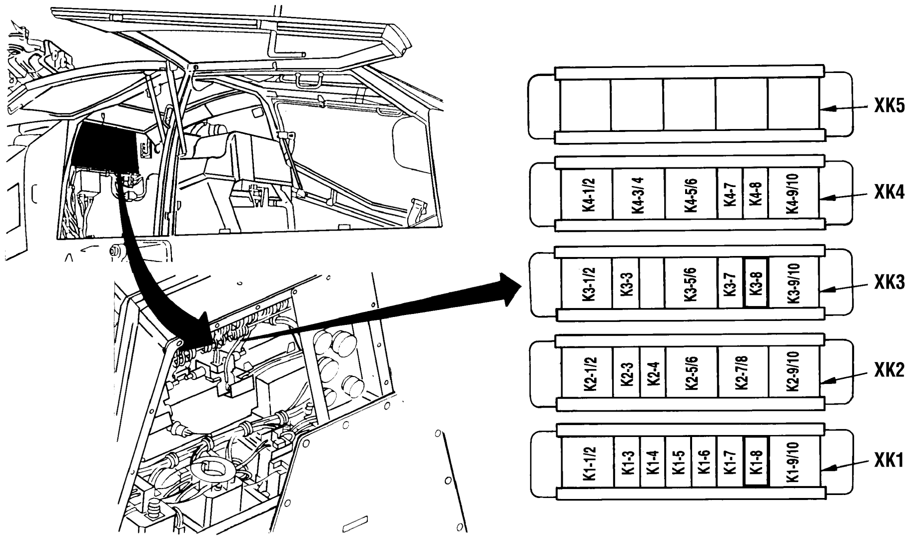
(5) With the anti-ice system on, the temperature of the NGB heater blankets and the inlet bleed air are monitored.

(a) If the temperature of the heater blankets fall below 225EF (107EC), or goes above 235EF (113EC) the respective ENG ANTI-ICE caution light illuminates.

(b) If the temperature in the bleed air tube decreases to 155EF (68EC) the respective ENG ANTI-ICE caution light illuminates.

(6) If either ENG 1 or ENG 2 ANTI-ICE caution light on the pilot's C/W/A panel illuminates, the CPG's ENG ANTI-ICE caution light also illuminates.

ENGINE ANTI-ICE FAIL RELAYS



12-94-12
85-308

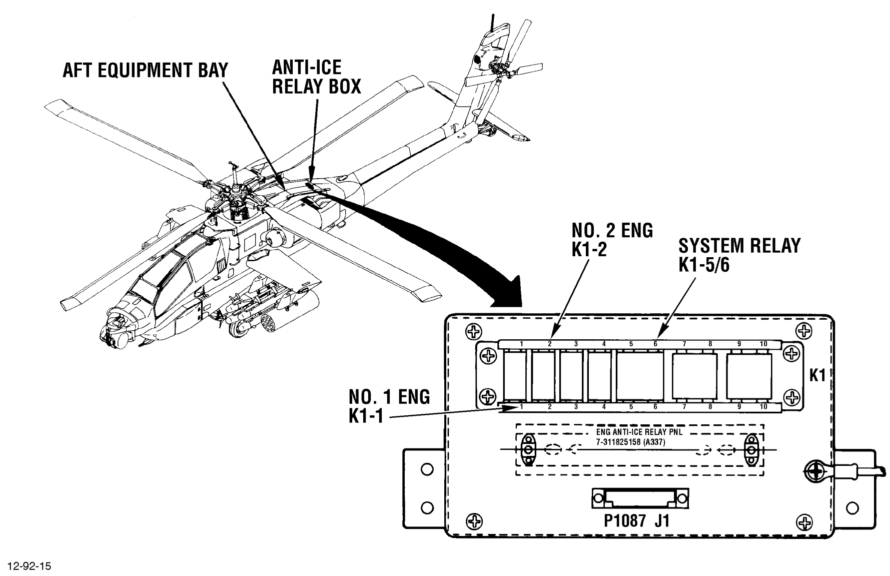
NOTES

e. Each engine anti-ice system has two relays plus a system relay. The anti-ice fail relays are located in the electrical power distribution center.

(1) K1-8 is the No. 1 engine ANTI-ICE fail relay.

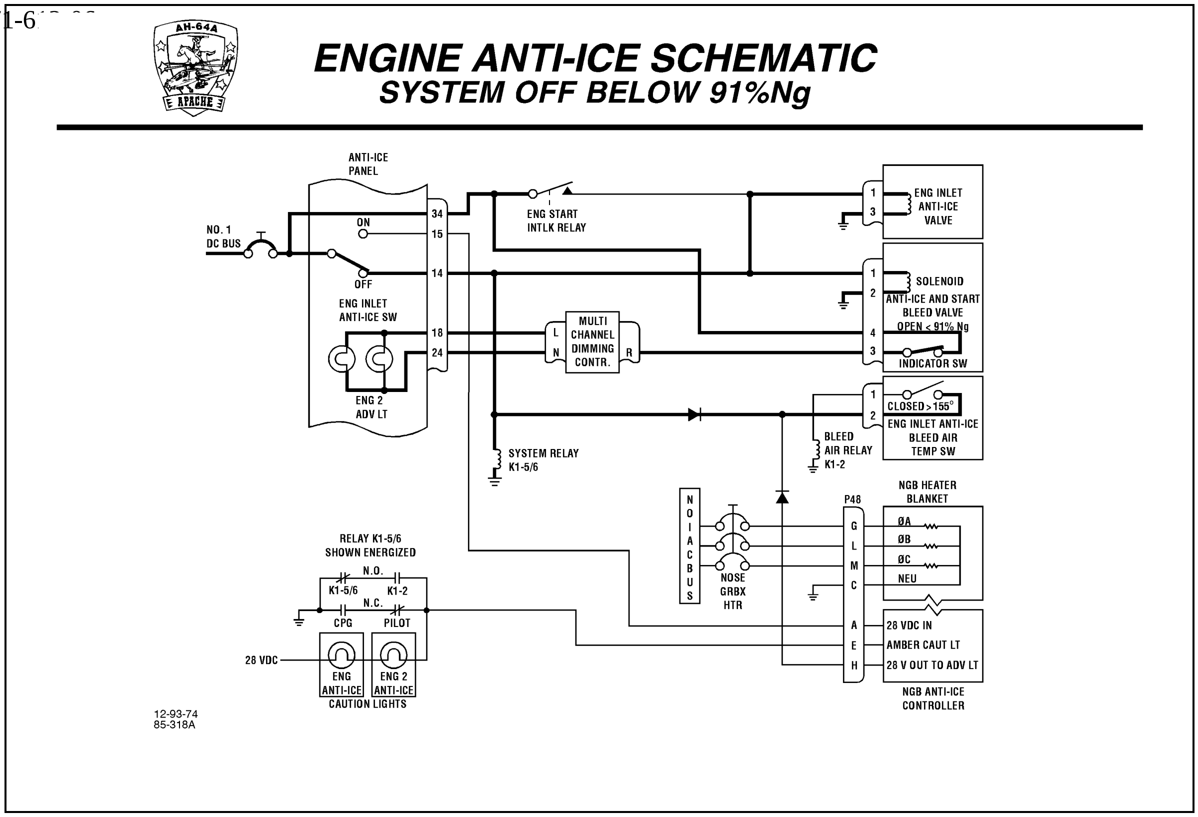
(2) K3-8 is the No. 2 engine ANTI-ICE fail relay.

ENGINE ANTI-ICE RELAY BOX LOCATION



NOTES

f. The remaining relays (K1-5/6 system relay, K1-2 for the No. 2 system, and K1-1 for the No. 1 system) are located on the ANTI-ICE relay panel on the inboard side of the No. 1 engine firewall.


AH-64A
APACHE
ENGINE ANTI-ICE SCHEMATIC
SYSTEM OFF BELOW 91%Ng
ANTI-ICE PANEL
NO. 1 DC BUS
ON
OFF
ENG INLET ANTI-ICE SW
ENG 2 ADV LT
34
15
14
18
24
ENG START INTLK RELAY
MULTI CHANNEL DIMMING CONTR.
L
N
R
ENG INLET ANTI-ICE VALVE
SOLENOID
ANTI-ICE AND START BLEED VALVE OPEN < 91% Ng
INDICATOR SW
CLOSED > 155°
ENG INLET ANTI-ICE BLEED AIR TEMP SW
BLEED AIR RELAY K1-2
SYSTEM RELAY K1-5/6
NOIACBUS
NOSE GRBX HTR
P48
NGB HEATER BLANKET
ØA
ØB
ØC
NEU
28 VDC IN
AMBER CAUT LT
28 V OUT TO ADV LT
NGB ANTI-ICE CONTROLLER
RELAY K1-5/6 SHOWN ENERGIZED
N.O.
K1-5/6
K1-2
N.C.
CPG
PILOT
28 VDC
ENG ANTI-ICE
ENG 2 ANTI-ICE
CAUTION LIGHTS
12-93-74
85-318A

NOTES

NOTE: The schematic represents the No. 2 engine anti-ice system. Operation of the No.1 engine is identical to the No. 2.

g. Anti-ice system electrical operation

(1) Operation with system OFF

(a) 28 vdc from the No. 1 DC bus is available to the ENG INLET ANTI-ICE switch, the solenoid of the anti-ice and start bleed valve and the indicator switch. The indicator switch is closed when the valve is open and open when the valve is closed.

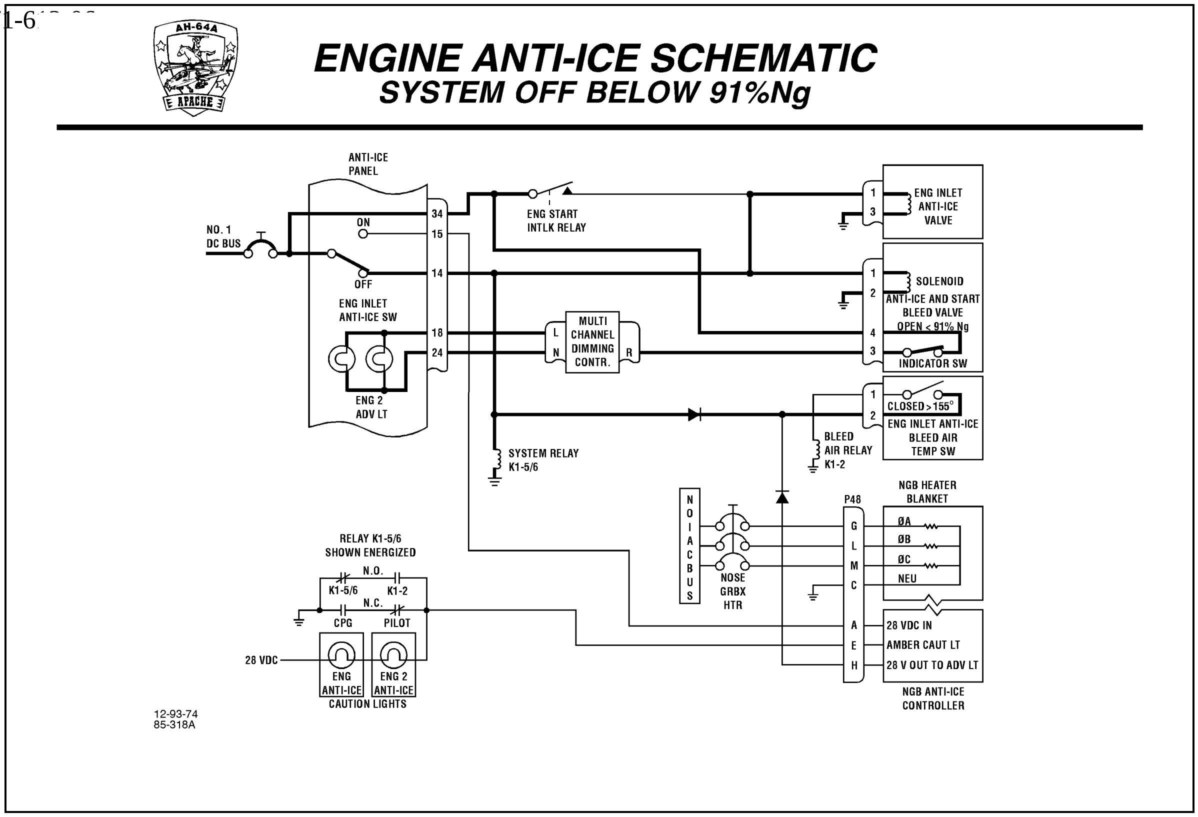
(b) When the ENG INLET ANTI-ICE switch is placed to the OFF position, power is applied to the coil of relay K1-5/6, and through a diode, to the open bleed air temperature switch. Relay K1-5/6 has one set of normally closed contacts, and one set of normally open contacts. These contacts work in conjunction with K1-2 (K1-1 for the No. 1 engine) to control the ENG 2 ANTI-ICE FAIL caution light. When K1-5/6 is energized, one set of contacts opens the circuit from the normally closed (NC) contacts of the bleed air relay (K1-2) to the No. 2 engine ANTI-ICE caution light to prevent the illumination of the caution light.

NOTE: The terms normally open (NO) and normally closed (NC) refer to the positions of the relay contacts in the de-energized state. In this schematic, the contacts of relay K1-5/6 are shown in the energized state; The NO contacts are energized closed and the NC contacts are energized open.

(c) Power is supplied through the ENG INLET ANTI-ICE switch to the solenoids of the eng inlet anti-ice valves and the anti-ice and start bleed valves. The single anti-ice switch controls both engine anti-ice systems.

1) The engine inlet anti-ice valve is energized closed. This prevents engine bleed air from entering the duct on which the temperature switch is located. The temperature switch closes when a temperature of 155 degrees F is sensed. The open temperature switch keeps the bleed air relay (K1-2) de-energized.

2) The anti-ice and start bleed valve solenoid is electrically energized, but the valve is mechanically held open by the engine Hydro-mechanical Unit (HMU) when the engine speed is below 91% N_G. The indicator switch is closed when the valve is open.


AH-64A
APACHE
ENGINE ANTI-ICE SCHEMATIC
SYSTEM OFF BELOW 91%Ng
ANTI-ICE PANEL
NO. 1 DC BUS
ON
OFF
ENG INLET ANTI-ICE SW
ENG 2 ADV LT
34
15
14
18
24
ENG START INTLK RELAY
MULTI CHANNEL DIMMING CONTR.
L
N
R
SYSTEM RELAY K1-5/6
ENG INLET ANTI-ICE VALVE
SOLENOID
ANTI-ICE AND START BLEED VALVE OPEN < 91% Ng
INDICATOR SW
CLOSED > 155°
ENG INLET ANTI-ICE BLEED AIR TEMP SW
BLEED AIR RELAY K1-2
NGB HEATER BLANKET
P48
ØA
ØB
ØC
NEU
NOIACBUS
NOSE GRBX HTR
28 VDC IN
AMBER CAUT LT
28 V OUT TO ADV LT
NGB ANTI-ICE CONTROLLER
RELAY K1-5/6 SHOWN ENERGIZED
N.O.
N.C.
K1-5/6
K1-2
CPG
PILOT
28 VDC
ENG ANTI-ICE
ENG 2 ANTI-ICE
CAUTION LIGHTS
12-93-74
85-318A

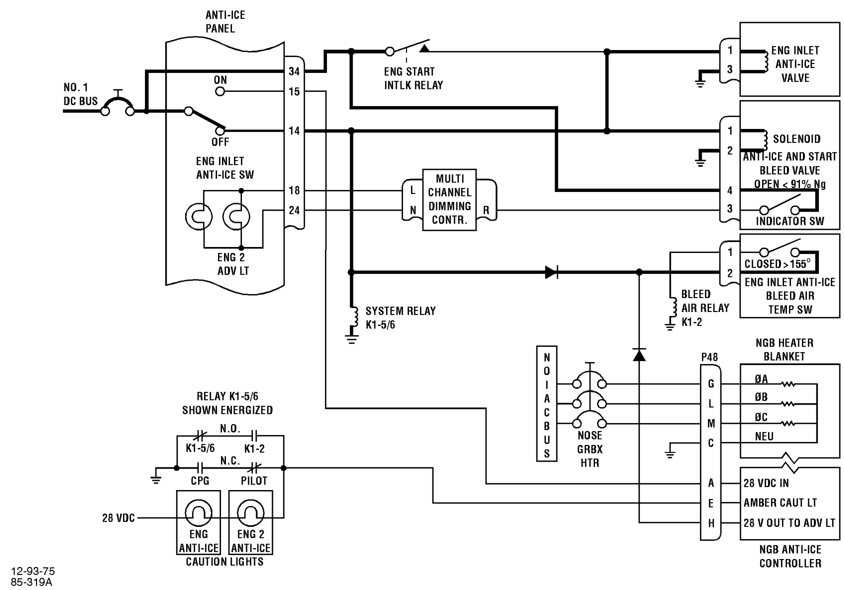
NOTES

(d) 28 vdc is routed through the closed indicator switch to pin R of the multichannel dimming controller. With this input, the controller provides power and ground to illuminate the ENG 2 ANTI-ICE caution light.

(e) When the anti-ice system is OFF and the engines are operating below 91% N_G, both engine anti-ice caution lights are extinguished and both green ENG 1 and ENG 2 advisory lights are illuminated.

ENGINE ANTI-ICE SCHEMATIC

SYSTEM OFF ABOVE 91%Ng



NOTES

(f) When engine speed increases above 91% N_G, the HMU allows the anti-ice and start bleed valve to be energized closed. When the valve closes, the indicator switch opens. The open switch removes the signal into pin R of the multi-channel dimming controller. The controller causes the green advisory lights to extinguish.

(g) When the anti-ice system is off and the engines are operating above 91% N_G, the advisory lights and the caution lights are extinguished.

(h) Malfunctions with the system OFF, engine speed above 91% N_G

1) If the engine inlet anti-ice valve fails open, hot bleed air enters the duct on which the temperature switch is mounted. The temperature switch closes when a temperature of 155 degrees F is sensed.

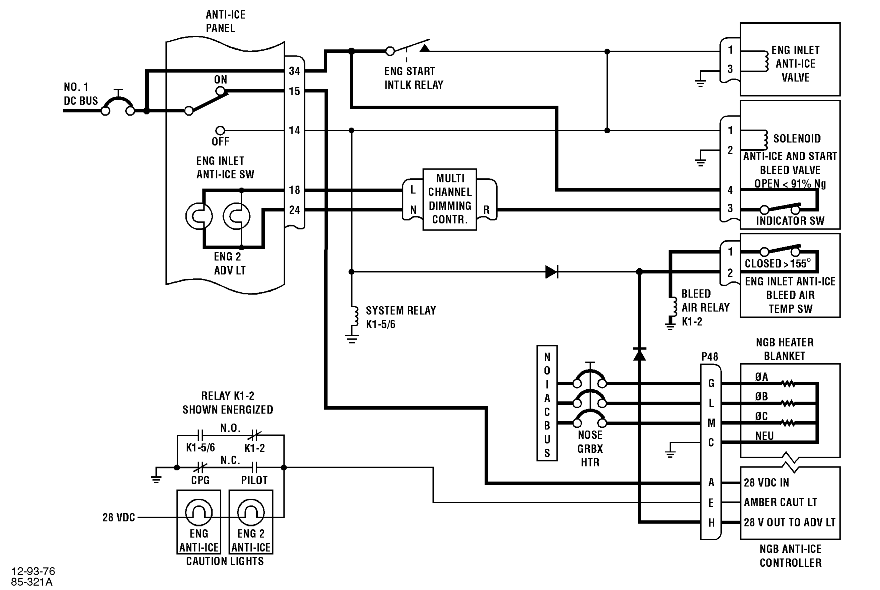
a) When the temperature switch is closed, 28 vdc is routed to the coil of the bleed air relay (K1-2).

b) When K1-2 energizes, The NO contacts close and complete a ground path from the ENG 2 ANTI-ICE caution light through energized-closed NO contacts of relay K1-5/6. The anti-ice caution lights are powered from the DC emergency bus. When a ground is provided, the light illuminates.

2) If the anti-ice and start bleed valve fails open, the indicator switch closes, causing signal to be applied to pin R of the multi-channel dimming controller. The controller supplies power and ground to illuminate the green ENG 2 advisory light.

3) The NGB anti-ice controller monitors the NGB anti-ice system. If the NGB anti-ice systems malfunctions, the controller provides an internal ground to pin E of the NGB anti-ice connector (P48), which causes the ENG 2 ANTI-ICE FAIL caution light to illuminate.

ENGINE ANTI-ICE SCHEMATIC
SYSTEM ON



NOTES

NOTE: The schematic represents the No. 2 engine anti-ice system. Operation of the No.1 engine is identical to the No. 2.

(2) Operation with system ON

(a) When the ENG INLET ANTI-ICE switch is placed to the ON position, power is removed from the anti-ice and start bleed valve and the engine inlet anti-ice valve solenoids. The valves are spring-loaded open. Removing power from the solenoids allows the valves to open.

(b) The indicator switch inside the anti-ice and start bleed valve closes when the valve is open, supplying a signal to pin R of the multi-channel dimming controller. The controller causes the green advisory light to illuminate.

(c) When the engine anti-ice system is turned on, the amber ENG ANTI-ICE FAIL caution lights illuminate until the temperature switch in the engine inlet bleed air duct senses 155 degrees F and the NGB heater fairings reach 225 degrees F.

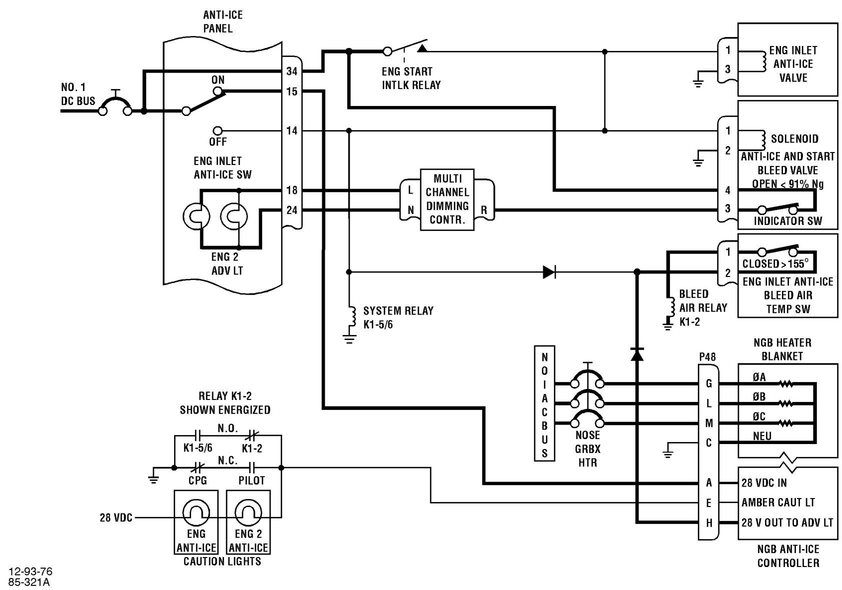
(d) 28 vdc is applied through the ENG INLET ANTI-ICE switch ON position to pin A of the NGB heater controller. The controller causes 3-phase 115 vac to be applied to the heaters. The controller controls the ac voltage to maintain the fairings at 225 to 235 degrees F. Until the fairings reach 225 degrees F, the NGB controller keeps an internal ground applied to pin E of connector P48 which keeps the respective anti-ice caution light illuminated. The ground is removed when NGB fairings reach 225 degrees F and the caution light extinguishes.

(e) If the NGB heater blankets are functioning properly, 28 vdc exits pin H and be applied to the coil of the bleed air relay K1-2. When the bleed air relay energizes, the NO contacts close and the NC contacts open.

1) The energized closed N.O. contacts complete a ground from the caution light to the de-energized open N.O. contacts of the system relay (K1-5/6). The open contacts of K1-5/6 prevent the caution light from illuminating.

2) The energized open N.C. contacts open the ground circuit from the caution light to the de-energized closed N.C. contacts of relay K1-5/6. The open contacts of K1-2 prevent the caution light from illuminating.

ENGINE ANTI-ICE SCHEMATIC
SYSTEM ON



NOTES

(f) When the anti-ice system is on and operating properly, the green anti-ice advisory lights are illuminated and the amber caution lights are extinguished.

(g) During either engine start, the engine start interlock relay contacts are energized closed by the start circuitry. This causes both valves on both engines to be energized closed during engine start.

(3) Malfunctions with the system on, engine speed above 91% NG

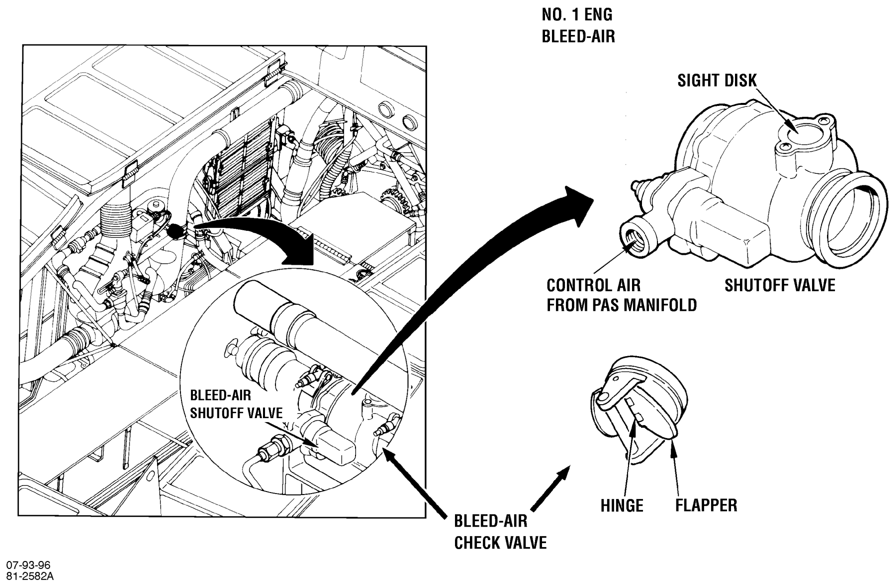
NOTE: The engine inlet anti-ice valve and the anti-ice and start bleed valve are spring-loaded open. The possibility of either failing to open is very remote.

(a) If the anti-ice and start bleed valve should not open when the system is turned on, the indicator switch would remain open. This would prevent the green advisory light from illuminating. The amber anti-ice caution light will not illuminate. The green advisory lights are out of the pilot's normal line of sight and would probably not be noticed. However, with one engine anti-ice and start bleed valve failed closed, there is a difference of TGT between the engines. The engine with the open valve will have a higher TGT indication. This should be the fault symptom the pilot notices.

(b) If the engine inlet anti-ice valve were to fail closed when the system is on, the temperature switch would open when temperature in the duct decrease to less than 155 degrees. Relay K1-2 (K1-1 for the No. 1 engine) would de-energize. The N.C. contacts would be energized closed and provide a ground for the amber anti-ice caution light through the de-energized closed N.C. contacts of the system relay (K1-5/6). The engine with the closed valve would have a lower TGT indication than the other engine.

(c) If the NGB anti-ice system should malfunction, the NGB anti-ice controller would provide an internal ground to pin E of connector P48 (P47 for No. 1 engine) and the anti-ice fail light would illuminate.

BLEED-AIR SHUTOFF VALVE AND CHECK VALVE



NOTES

h. Fifth stage compressor bleed air manifold

(1) Provides a connection at the compressor stator case bleed port and allows fifth-stage compressor bleed air to flow to the bleed air shutoff valve.

(2) Attached at the No. 1 engine compressor stator at the 9 o'clock position.

(3) One-and-a-quarter-inch-diameter titanium tubing.

i. Bleed air shutoff valve

(1) Automatically allows flow of No. 1 engine bleed air to the PAS manifold when shaft-driven compressor outlet pressure drops below 10-14 psi.

(2) Left side of aft equipment bay.

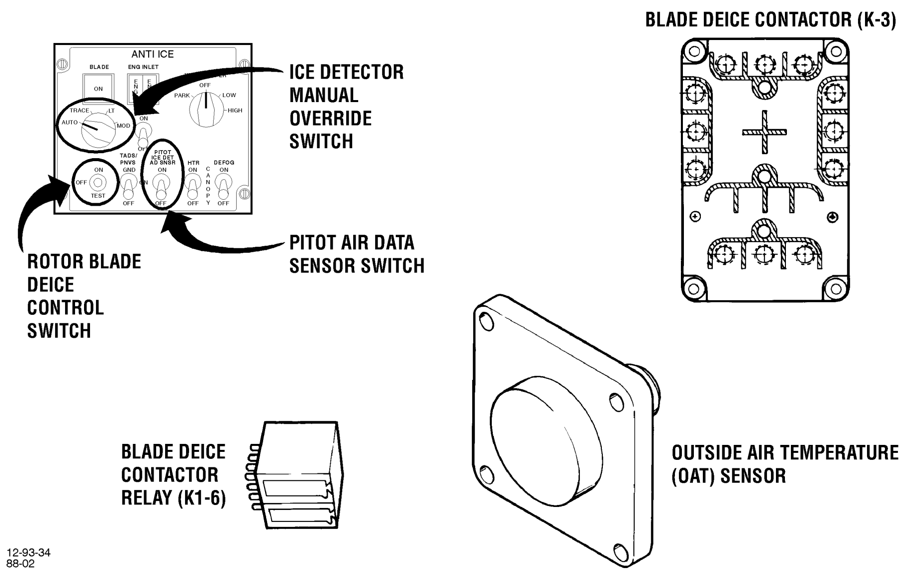
(3) Operation

(a) The valve is pressure operated and controlled poppet valve, spring-loaded closed, and enclosed in an aluminum body with a visual position indicator.

(b) A position indicator shows poppet position (either opened or closed).

NOTE: Bleed air shutoff valve operation is discussed in greater detail later in this lesson.

ROTOR BLADE DEICE COMPONENTS I



NOTES

CAUTION

Do not operate blade deice system with rotor blade erosion strips installed. Failure to do so could result in damage to rotor blades.

CAUTION

Temperature and resistance measurements are done in a stable temperature environment; with blade temperature as close as possible to air temperature to insure proper system calibration. Ensure that blades are not heated or cooled by any energy source during this maintenance. Failure to maintain stable blade temperature will cause an improper system adjustment.

C. Rotor blade deicing electrical system

1. Provides controlled ice removal from the main and tail rotor blades in trace to moderate icing conditions.

2. The main and tail rotor blades can be deiced automatically or manually.

3. The system can be functionally tested under full load conditions.

4. Rotor blade deice components

a. Rotor blade deice control switch

b. Ice detector manual override switch

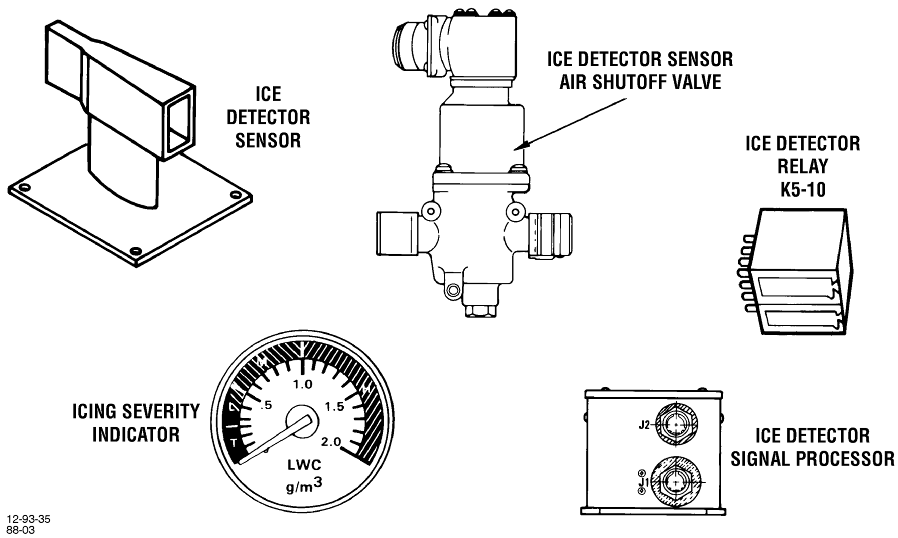
c. PITOT/ICE DET/AD SNSR switch

d. Blade deice contactor (K3)

e. Blade deice contactor relay (K1-6)

f. Outside air temperature (OAT) sensor

ROTOR BLADE DEICE COMPONENTS II



NOTES

g. Ice detector sensor

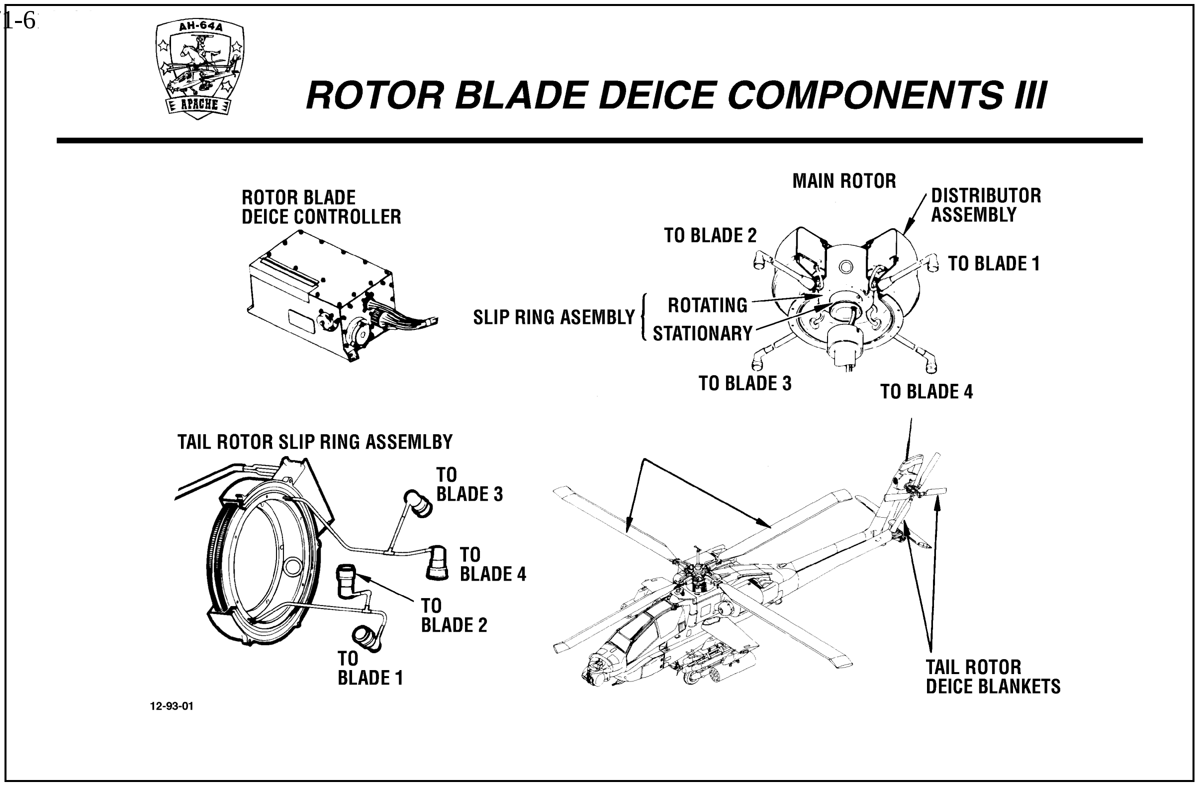
h. Ice detector sensor air shutoff valve

i. Ice detector relay (K5-10)

j. Icing severity indicator

k. Ice detector signal processor

071-6


ROTOR BLADE DEICE COMPONENTS III
ROTOR BLADE
DEICE CONTROLLER
MAIN ROTOR
DISTRIBUTOR
ASSEMBLY
TO BLADE 2
TO BLADE 1
SLIP RING ASEMBLY
ROTATING
STATIONARY
TO BLADE 3
TO BLADE 4
TAIL ROTOR SLIP RING ASSEMLBY
TO
BLADE 3
TO
BLADE 4
TO
BLADE 2
TO
BLADE 1
TAIL ROTOR
DEICE BLANKETS
12-93-01

NOTES

l. Rotor blade deice controller

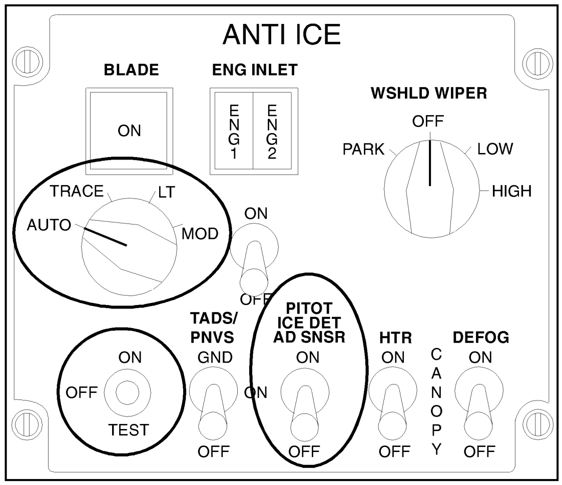
m. Main rotor distributor assembly

n. Slip ring assembly (main and tail rotor)

o. Main and tail rotor deice blankets

PILOTs ANTI-ICE CONTROL PANEL

BLADE DEICE SWITCHES



NOTES

5. Pilot's anti-ice control panel blade deice switches

    a. ANTI-ICE system ON, OFF, TEST

    b. Ice detector manual override

    c. PITOT/ICE DET/AD Sensor

6. ANTI-ICE system ON, OFF, TEST switch

    a. Located on the left lower corner of the ANTI-ICE control panel.

        (1) Allows pilot to control blade deice system.

        (2) Double-pole, double-throw, three position toggle switch.

            (a) OFF (center position) turns off the rotor blade deice system.

            (b) ON turns the system on.

            (c) TEST allows the system to be functionally tested under full load conditions.

7. Ice detector manual override switch

    a. Allows the pilot to select automatic or manual rotor blade deicing.

    b. Located on the left center of the ANTI-ICE control panel in the pilot's left console.

    c. Single-pole, four-position rotary switch.

        (1) AUTO permits automatic blade deicing.

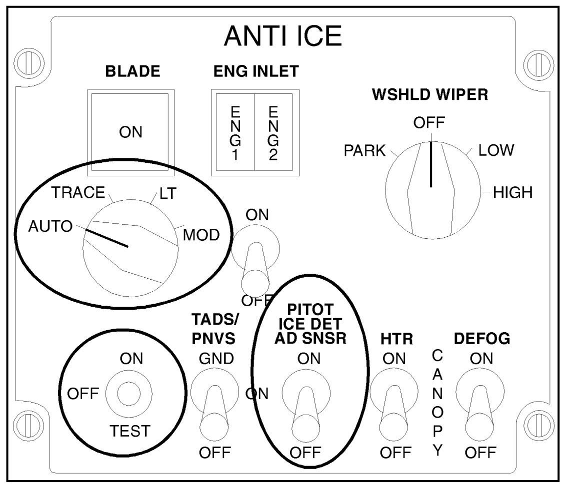
        (2) TRACE is a manual mode for trace icing conditions.

        (3) LT is a manual mode for light icing conditions.

        (4) MOD is a manual mode for moderate icing conditions.

PILOTs ANTI-ICE CONTROL PANEL

BLADE DEICE SWITCHES



12-93-36
88-05

NOTES

8. PITOT/ICE DET/AD SENSOR switch

   a. In addition to previously identified functions, it controls operation of the:

      (1) Ice detector sensor shroud heater.

      (2) PAS air flow to aspirate the ice detector sensor.

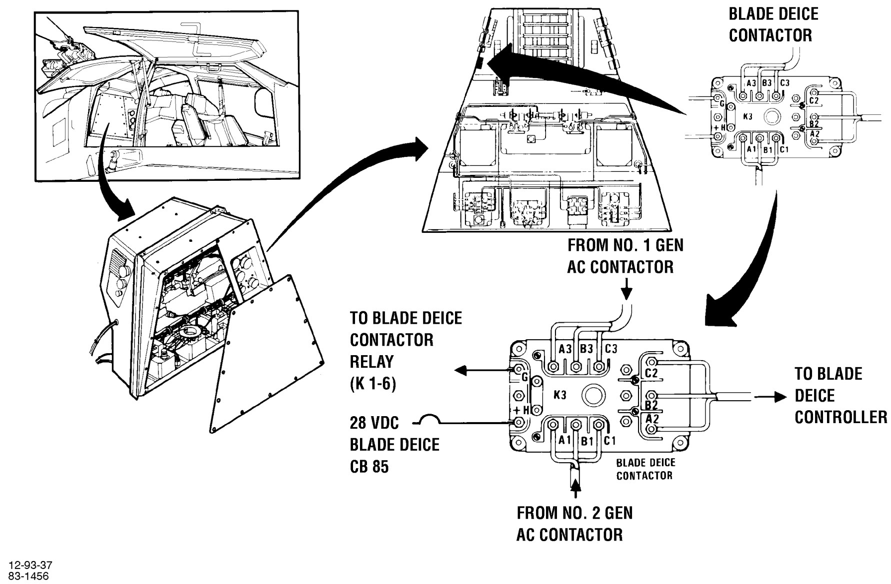
   b. Located on lower center of the ANTI-ICE control panel in the pilot's left console.

   c. Two-position toggle switch marked ON and OFF.

      (1) ON - energizes the ice detector relay (K5-10).

      (2) OFF - system is off.

BLADE DEICE CONTACTOR (K3)



NOTES

9. Blade deice contactor (K3)

   a. When energized, applies three-phase, 115/200 VAC to the rotor blade deice controller.

   b. Provides overcurrent protection for the rotor blade deice controller AC input circuitry.

   c. Located in the electrical power distribution center behind the pilot's seat.

   d. Compact, lightweight (2.75 pounds [1.2 kilograms]), solid-state LRU. The front face has 17 terminal studs. Only 11 of the terminal studs are used to provide contactor power and control connections.

   e. Control coil power (28 VDC) and return are supplied by the BLADE DEICE circuit breaker (CB85) and the blade deice contactor relay (K1-6), respectively.

   f. Directly connected to both AC generator contactors.

   g. Each AC generator contactor supplies three-phase, 115/200 VAC to K3.

   h. Contains a solid-state current sensing and time delay circuit that:

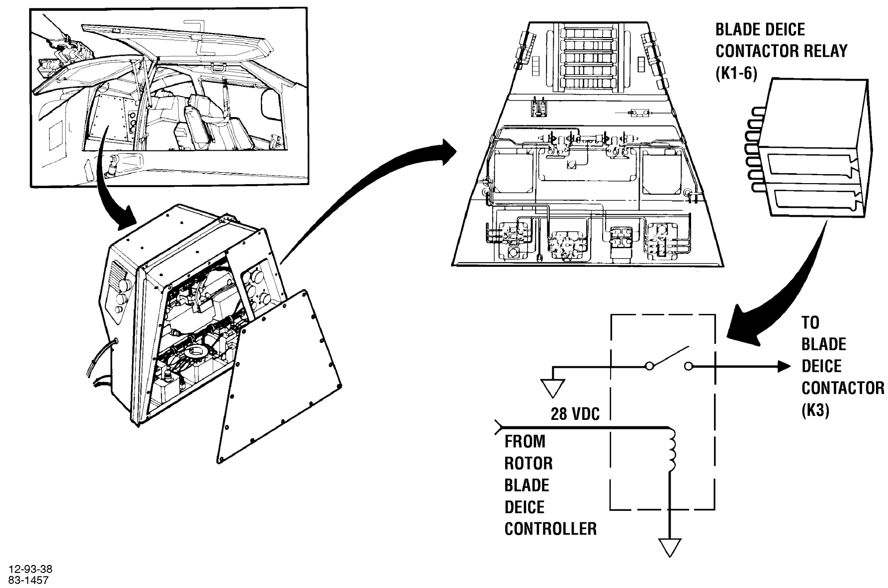
      (1) Disconnects three-phase, 115/200 VAC from the blade deice controller if input load current exceeds 60 amperes for more than 2 seconds.

      (2) Trips the BLADE Deice circuit breaker (CB85) and de-energize the blade deice contactor within 2 seconds after AC power is disconnected from the controller.

   i. The No. 2 AC system is the primary power source for the rotor blade deice system.

   j. Automatic switching ensures power for rotor blade deice operation if only one AC electrical power system is operational.

BLADE DEICE CONTACTOR RELAY (K1-6)



NOTES

10. Blade deice contactor relay (K1-6)

    a. Controls operation of the blade deice contactor.

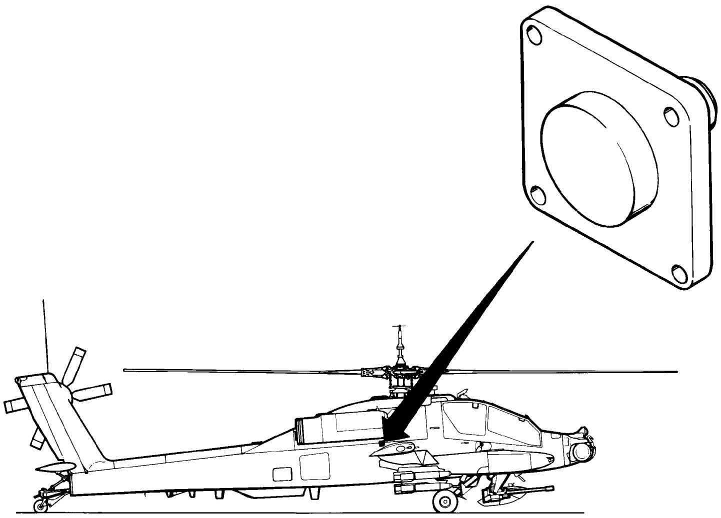
    b. Located in the electrical power distribution center behind the pilot's seat.

    c. Small [1 x 1 x 1 inch (2.5 x 2.5 x 2.5 centimeters)], lightweight [1.4 ounce (39.6 grams)], solid-state LRU.

    d. Energized by 28 VDC from the blade deice controller.

    e. When energized, provides a ground to energize the blade deice contactor.

OUTSIDE AIR TEMPERATURE SENSOR



12-92-05

NOTES

11. OAT sensor

    a. Provides OAT information to the blade deice controller to control main and tail rotor heater "on" times.

    b. Located between the right wing and No. 2 engine nacelle.

    c. It is a resistive temperature sensor with a positive temperature coefficient.

    d. Operation

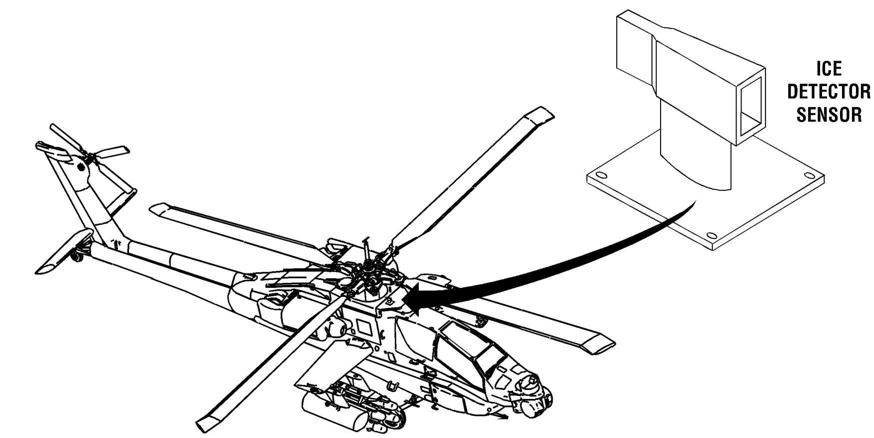
        (1) As temperature decreases, sensor resistance decreases.

        (2) As temperature increases, sensor resistance increases.

        (3) Changes in sensor resistance are input to the rotor blade deice controller.

        (4) The blade deice controller varies the main and tail rotor heater "on" time from 0 to 22 seconds, depending on temperature.

ICE DETECTOR SENSOR



12-93-39
88-07

NOTES

12. Ice detector sensor

    a. Provides a signal to the ice detector signal processor proportional to the amount of ice detected.

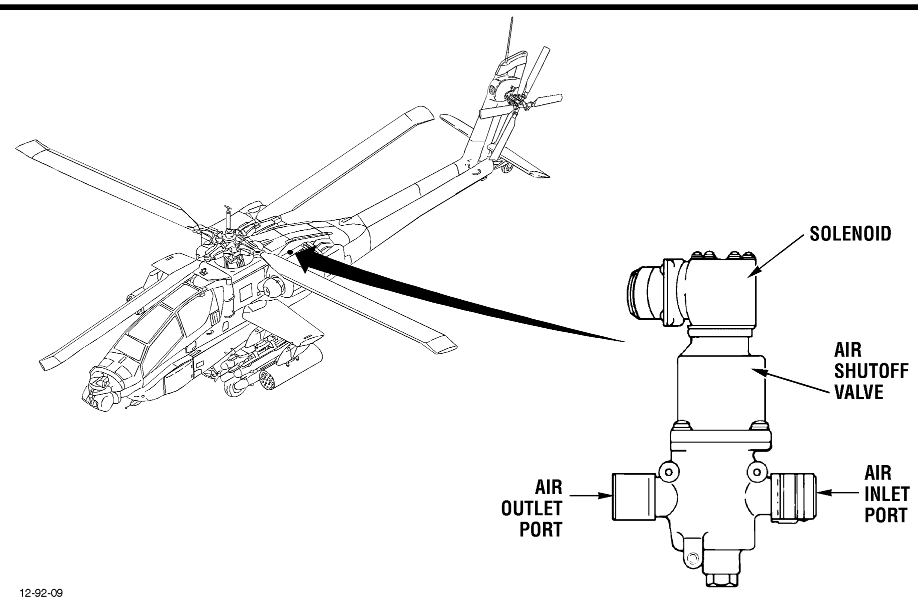
    b. Mounted on the top right side of the dog house fairing, forward of the main rotor head.

    c. A vibrating probe that provides an output signal of which the frequency is proportional to true ambient liquid water content (LWC) (amount of ice).

    d. Contains a 28 VDC heater to remove ice from the sensor head and a 115/200 VAC heater to prevent ice from forming on the ice detector sensor shroud.

    e. Inspected during all phase inspections.

ICE DETECTOR SENSOR AIR SHUTOFF VALVE



NOTES

13. Ice detector sensor air shutoff valve

    a. Controls PAS airflow to the ice detector sensor housing.

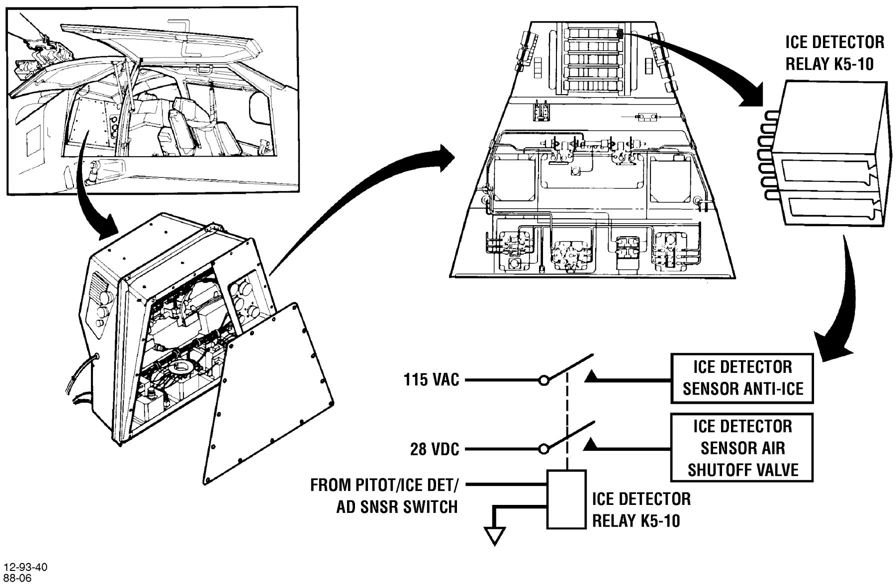
    b. Mounted on the upper fairing in the left side of the aft equipment bay, inboard of the No. 1 engine.

    c. Is a solenoid-operated poppet valve that is electrically energized open, and spring-loaded closed.

    d. The valve has one electrical connector and two air ports.

    e. The valve is controlled by the PITOT/ICE DET/AD SNSR switch on the pilot's anti-ice control panel. When the switch is placed to the ON position, the valve is energized open to allow PAS air to flow to the ice detector sensor housing.

ICE DETECTOR RELAY
(K5-10)



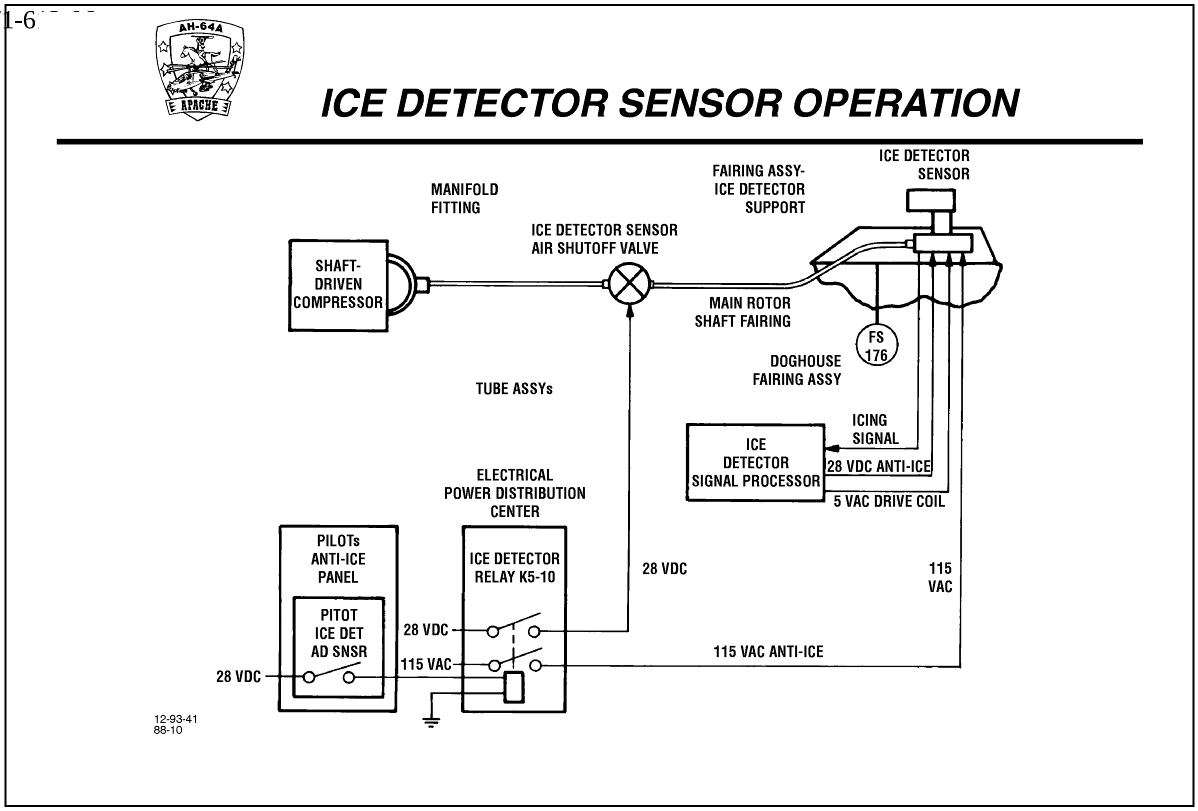
NOTES

14. Ice detector relay (K5-10)

    a. When energized, the ice detector relay applies 28 VDC to open the ice detector sensor air shutoff valve and applies single-phase 115/200 VAC from the ICE DET HTR to the anti-ice heater in the ice detector sensor housing.

    b. Mounted in the electrical power distribution center, behind the pilot's seat.

    c. Small (1 x 1 x 1 inch [2.5 x 2.5 x 2.5 centimeters]), lightweight (1.4 ounce [39.7 grams]), solid-state LRU.


ICE DETECTOR SENSOR OPERATION
MANIFOLD FITTING
FAIRING ASSY- ICE DETECTOR SUPPORT
ICE DETECTOR SENSOR
ICE DETECTOR SENSOR AIR SHUTOFF VALVE
SHAFT-DRIVEN COMPRESSOR
MAIN ROTOR SHAFT FAIRING
FS 176
DOGHOUSE FAIRING ASSY
TUBE ASSYs
ICING SIGNAL
ICE DETECTOR SIGNAL PROCESSOR
28 VDC ANTI-ICE
5 VAC DRIVE COIL
ELECTRICAL POWER DISTRIBUTION CENTER
PILOTs ANTI-ICE PANEL
ICE DETECTOR RELAY K5-10
28 VDC
115 VAC
PITOT ICE DET AD SNSR
28 VDC
115 VAC
115 VAC ANTI-ICE
28 VDC
12-93-41
88-10

NOTES

15. Ice detector sensor operation

a. Probe operating power (5 "1 VAC) and heater power (28 VDC) are supplied by the ice detector signal processor. The 115/200 VAC heater power is provided by the No. 2 AC Bus via the ice detector relay (K5-10).

b. With 5 "1 VAC operating power applied, and no ice detected, the sensor probe vibrates at a preset frequency.

c. The sensor probe vibrations generate an output signal with a frequency proportional to that of the vibration frequency. The output signal is sent to the ice detector signal processor as a frequency comparison signal.

d. When the PITOT/ICE DET/AD SNSR switch is placed in the ON position, the ice detector relay is energized. The ice detector relay:

(1) Connects 115/200 VAC to the ice detector sensor housing for anti-icing of the housing.

(2) Applies 28 VDC to energize the ice detector sensor air shutoff valve open.

e. With the ice detector sensor air shutoff valve open, the ice detector sensor housing is supplied PAS air to ensure a constant airflow of 100 knots though the ice detector sensor housing, and across the vibrating probe. The PAS air flows through the housing, creating a venturi that draws ambient air across the probe.

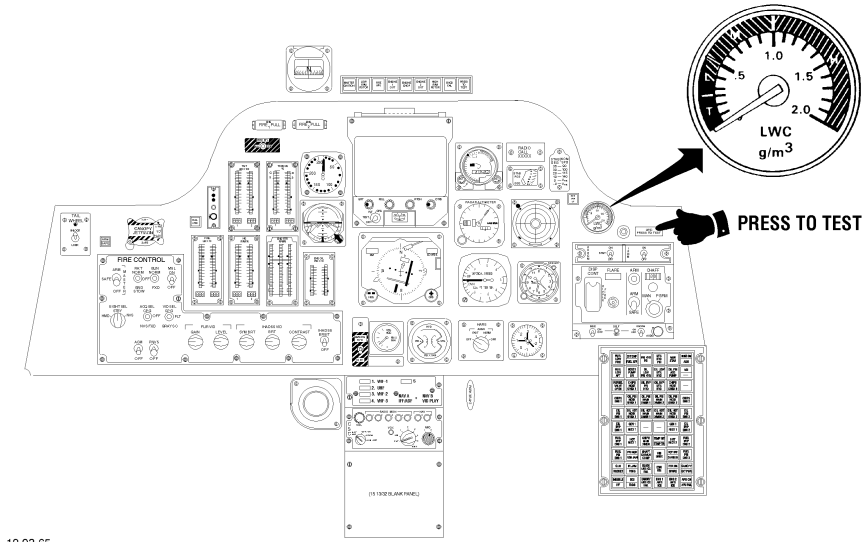
f. As ice forms on the sensor, the frequency of the sensor is altered due to the weight of the ice. The frequency is compared to a reference frequency by the ice detector signal processor.

g. If 0.005 to 0.015 inch (0.0127 to 0.0381 centimeters) of ice forms on the sensor, the frequency is altered to the point where the ice detector signal processor initiates the blade deice sequence.

h. When the ice detector signal processor determines that 0.005 to 0.015 inch (0.0127 to 0.0381 centimeters) of ice has formed on the sensor, the processor provides 28 VDC to deice the sensor.

i. As soon as the sensor is deiced, the processor removes the deice power and the sensor is able to detect ice build-up again.

ICING SEVERITY INDICATOR



12-93-65
86-101

NOTES

16. Icing severity indicator

    a. Provides the pilot with a visual indication of the degree of icing.

    b. Located on the right side of the pilot's instrument panel.

    c. Controlled by the ice detector signal processor.

    d. Analog indicator divided into four sections which indicate the degree of icing severity.

        (1) T - trace (0.00 to 0.25 LWC gram per cubic meter)

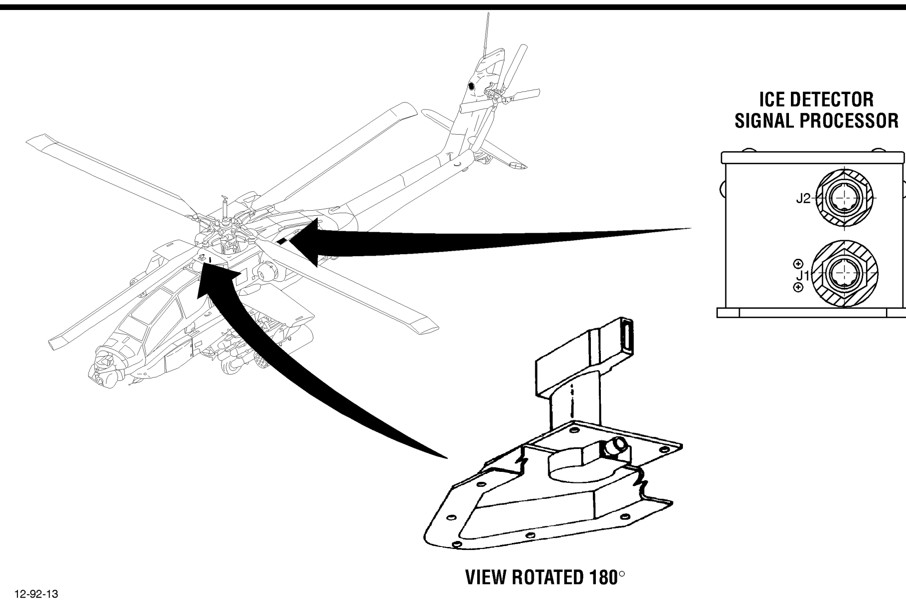
        (2) L - light (0.25 to 0.50 LWC gram per cubic meter)

        (3) M - moderate (0.5 to 1.0 LWC gram per cubic meter)

        (4) H - heavy (1.0 to 2.0 LWC grams per cubic meter)

    e. A press-to-test switch is mounted next to the indicator. When the test switch is pressed, it causes the indicator needle to drive to the 1.5 mark (approximately 3/4 scale needle deflection). This test checks only the gauge.

ICE DETECTOR SIGNAL PROCESSOR AND ICE DETECTOR SENSOR



NOTES

17. Ice detector signal processor

    a. Provides an output signal (to the rotor blade deice controller) which corresponds to the degree and rate of icing severity.

    b. Illuminates the pilot's C/W/A panel ENG ICE light when ice is detected by the sensing probe.

    c. Provides:

        (1) Operating and control power for the icing severity indicator.

        (2) Operating and heater power for the ice detector sensor.

    d. Located on the top center firewall of the No. 1 engine nacelle.

    e. Compact [4 x 4 x 4 inches (10 x 10 x 10 centimeters)] solid-state LRU with two connector receptacles for power and control connections.

    f. Powered by 28 VDC from the No. 3 DC Bus via the ICE DET Circuit Breaker (CB68).

    g. Contains a solid-state inverter which inverts 28 VDC to 5 "1 VAC for ice detector sensing head operation.

    h. Inspected during all phase maintenance inspections.

18. Operation

    a. With DC operating power applied, the ice detector signal processor is activated and supplies 5 "1 VAC 40 KHZ operating power to the ice detector sensor.

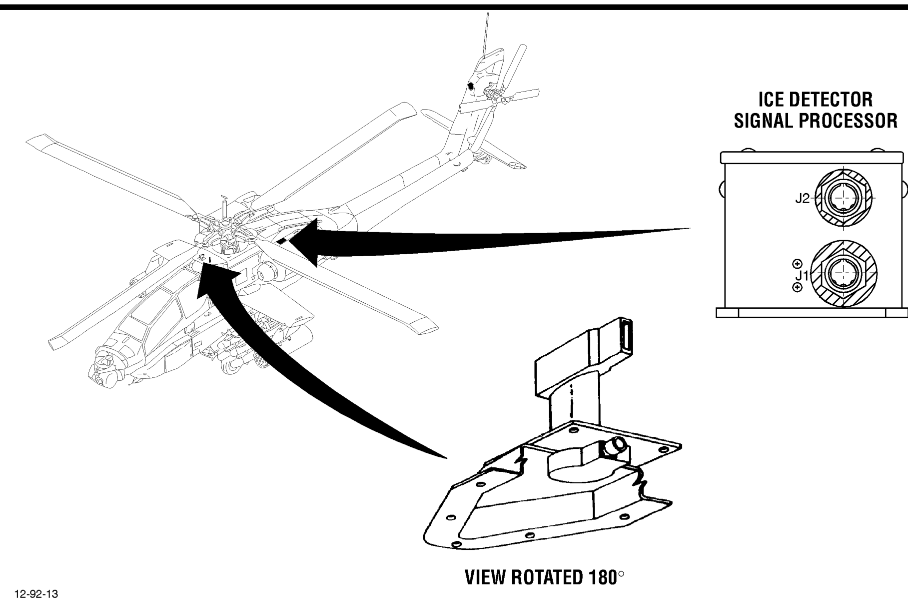
    b. The ice detector sensor vibrates and provides an icing signal back to the ice detector signal processor.

    c. The ice detector signal processor contains a frequency comparison circuit which compares the input signal frequency (from the ice detector sensor) to an internally generated reference frequency.

    d. Under no-ice conditions, the difference between the input frequency and the reference frequency is 200 "30 Hz.

    e. When icing conditions are present, and 0.005 to 0.015 inch (0.0127 to 0.0381 centimeters) of ice accumulates on the ice detector sensor probe, the frequency of the signal from the ice detector sensor decreases.

ICE DETECTOR SIGNAL PROCESSOR AND ICE DETECTOR SENSOR



NOTES

f. The frequency difference between the ice detector signal and the reference signal increases, causing the ice detector signal processor to trigger.

g. When triggered, the signal processor:

(1) Provides 28 VDC to illuminate the ENG ICE caution light.

(2) Provides a signal (to the icing severity indicator) which corresponds to the degree of icing.

(3) Provides 28 VDC heating voltage to the ice detector sensor for 6 seconds. (Deices the sensor probe when the ice detector signal processor determines that 0.015 inch of ice has accumulated.)

(4) Measures the heater cycling rate.

(5) Processes the ice detector sensor heater cycling rate with the difference between the ice detector sensor signal frequency and the signal processor reference frequency. The signal processor then provides 0-10 VDC signal (based upon the cycling rate and difference frequency) to the ice detector manual override switch (for use by the rotor blade deice controller). The signal corresponds to the degree and rate of icing.

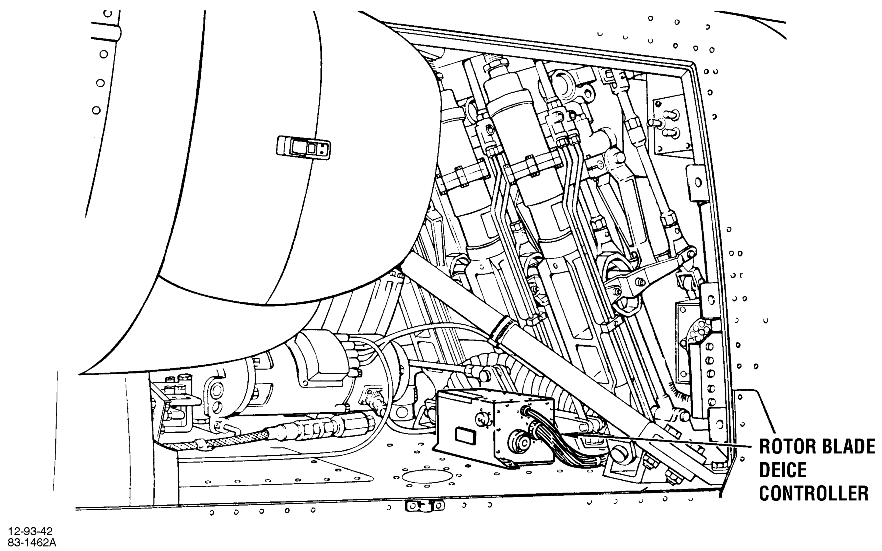
(6) Maintains these signals (except heating voltage) until 0.005 inch of new ice has formed, or 60 seconds has elapsed.

(a) If new ice is detected the process repeats; the ENG ICE light remains illuminated, the icing severity indicator indicates the amount of icing, heater voltage is provided to the ice detector sensor to deice it, and a signal is provided to the ice detector manual override switch (for use by the rotor blade deice controller).

(b) If 60 seconds elapses without the accumulation of ice greater than 0.005 inch, the signals are reset; the ENG ICE caution light is extinguished, the icing severity indicator indicates zero, the ice detector sensor does not heat, and the signal provided to the ice detector manual override switch (for use by the rotor blade deice controller) is removed.

ROTOR BLADE DEICE CONTROLLER

MAIN TRANSMISSION BAY (RIGHT SIDE)



NOTES

19. Rotor blade deice controller

a. Located in the main transmission bay, forward right side of the deck area.

b. Compares inputs from the following components to determine main and tail rotor heater operating times.

(1) OAT sensor

(2) Ice detector manual override switch

(a) Automatic mode - input from ice detector signal processor.

(b) TR, LT, or MOD - input generated by the deice controller.

(c) Main and tail rotor blade heating element current - By monitoring the current, the resistance can be determined. Maximum normal current for the main rotor heaters (opposing blades) is 43 amps. Maximum normal current for the tail rotor heaters (all four blades) is 28 amps.

c. Rectifies 115/200 VAC input power to "134 VDC. Provides the "134 VDC in timed pulses to the respective main and tail rotor heating elements.

d. Applies pulsed voltages to the main rotor distributor assembly to control sequential power application to the individual main rotor heating elements.

e. Provides a ground to illuminate the pilot's C/W/A panel BLADE ANTI-ICE FAIL light if one of the following components should fail.

(1) Main rotor distributor assembly

(2) Main rotor blade heater (open or short)

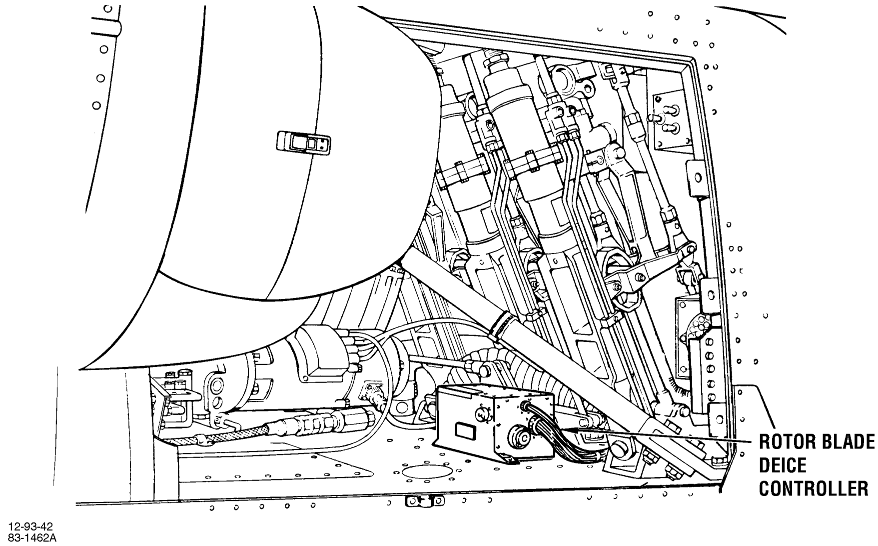
(3) Tail rotor blade heater (open or short)

(4) Rotor blade deice controller

f. Compact, solid-state LRU with three electrical connectors for power, control, and automatic test equipment (ATE) connections.

ROTOR BLADE DEICE CONTROLLER

MAIN TRANSMISSION BAY (RIGHT SIDE)



NOTES

g. Contains a rectification circuit that rectifies three-phase 115/200 VAC to positive and negative 134 VDC.

h. Contains an internal three-phase 115/200 VAC fan to provide cooling for internal components during deicing operation.

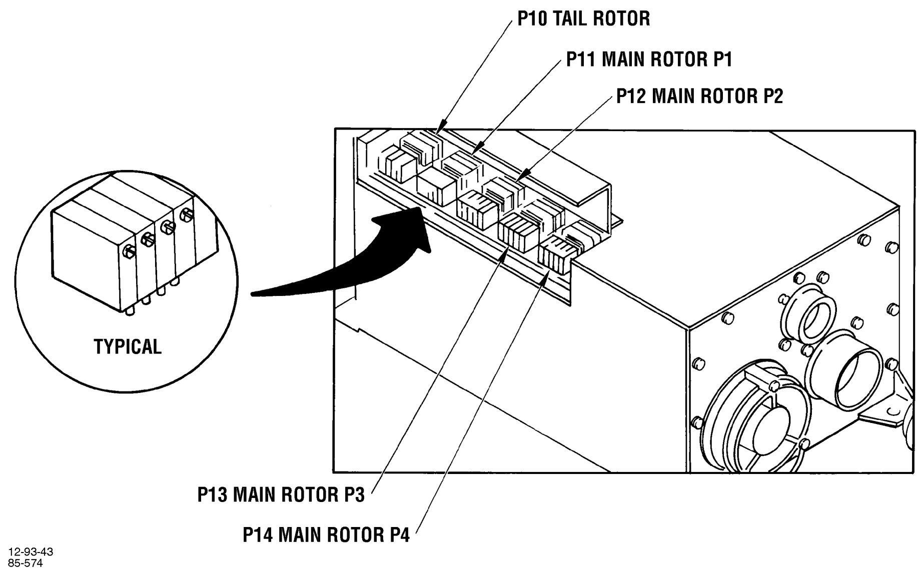
i. Powered by:

(1) 28 VDC from the No. 3 DC bus via the BLADE DEICE CONTR circuit breaker.

(2) Three-phase 115/200 VAC from the No. 1 or No. 2 generator.

j. All components located in the main transmission deck area are inspected during all phase maintenance inspections.

ROTOR BLADE DEICE CONTROLLER ADJUSTMENT MODULES



NOTES

20. Adjustment modules

a. Contain five adjustment modules used to set the reference resistance for each blade heater zone.

b. The controller uses the reference resistance and the amount of current required for each heater zone to determine the temperature of the blade.

(1) The heater elements have a positive temperature coefficient.

(2) The controller determines the temperature of the blade by comparing the reference resistance of each heater zone to the amount of current used by the heater.

c. The modules are labeled as follows.

(1) P10 - used for the tail rotor blades

(2) P11 - used for the No. 1 main rotor blade

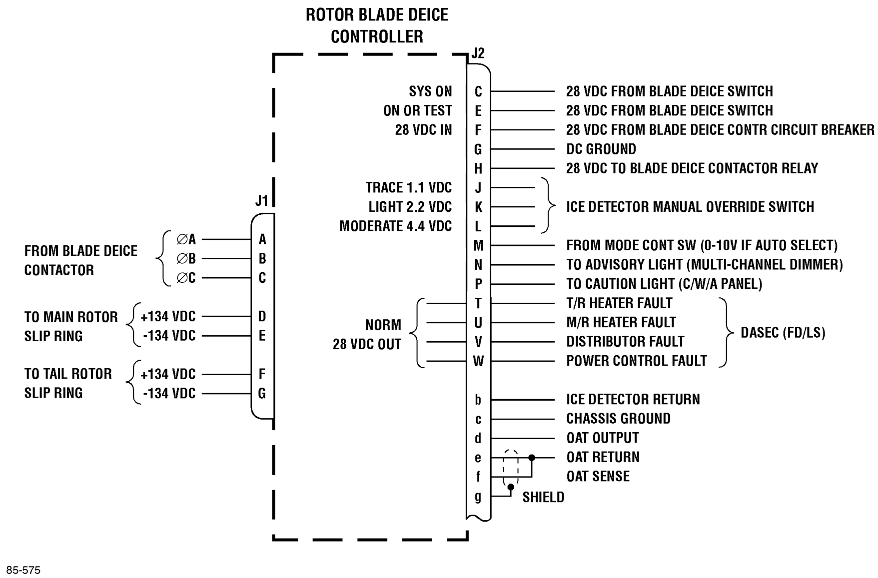
(3) P12 - used for the No. 2 main rotor blade

(4) P13 - used for the No. 3 main rotor blade

(5) P14 - used for the No. 4 main rotor blade

d. Each module has five variable resistors (one for each heater zone on the blade). The tail rotor module has five variable resistors, but only four are used (one for each blade).

ROTOR BLADE DEICE CONTROLLER INTERCONNECT DIAGRAM



NOTES

21. Operation

a. With the rotor blade deice control switch in the ON position, 28 VDC is applied to the rotor blade deice controller (J2, Pins C and E).

b. The rotor blade deice controller applies 28 VDC to the blade deice contactor relay (J2, Pin H). This causes the blade deice contactor (K3) to energize and apply three-phase 115/200 VAC to the rotor blade deice controller (J1, Pins A, B, and C).

c. The deice controller rectifies the 115/200 VAC input to +134 VDC and -134 VDC heater voltage (J1, Pins D and E for main rotor and Pins F and G for tail rotor).

d. Heater voltage "on" (application) time is controlled by two independent control circuits.

(1) Time control

(a) Controls heater "on" time over a range of 0 to 22 seconds.

(b) Responds to input data from the OAT sensor (J2, pins e and f).

1) At "1.05EC, heater "on" time is 0.0 second.

2) At -23.0EC, heater "on" time is 17.6 seconds.

(2) Temperature control

(a) Monitors the current and resistance of the blade heating elements.

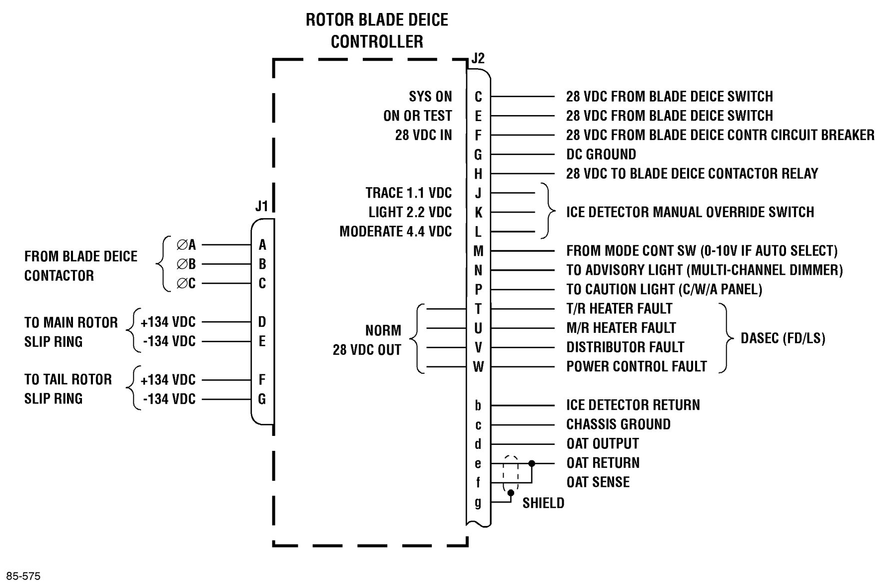
(b) Terminates heating as soon as a preset value of resistance is reached.

e. Main and tail rotor heater voltage application is synchronized by the rotor blade deice controller to prevent both systems from operating at the same time and creating an overcurrent condition.

f. Main rotor heater voltage application is further controlled by sequential switching signals from the rotor blade deice controller to the main rotor slip ring and the main rotor distributor.

g. These signals cause power to be applied sequentially to the individual opposing main rotor blade heating elements.

ROTOR BLADE DEICE CONTROLLER INTERCONNECT DIAGRAM



NOTES

h. The blade heater "off" time is determined by the controller as a function of the ice detector signal processor inputs and the ice detector manual override switch position.

(1) With the ice detector manual override switch in the AUTO position, input to the deice controller controller is 0 to 10 VDC as determined by the ice detector sensor and ice detector signal processor (J2, Pin M).

(a) At 0.0 VDC input, the system does not energize.

(b) At 10.0 VDC input, off time between heating cycles would be less than 60 seconds.

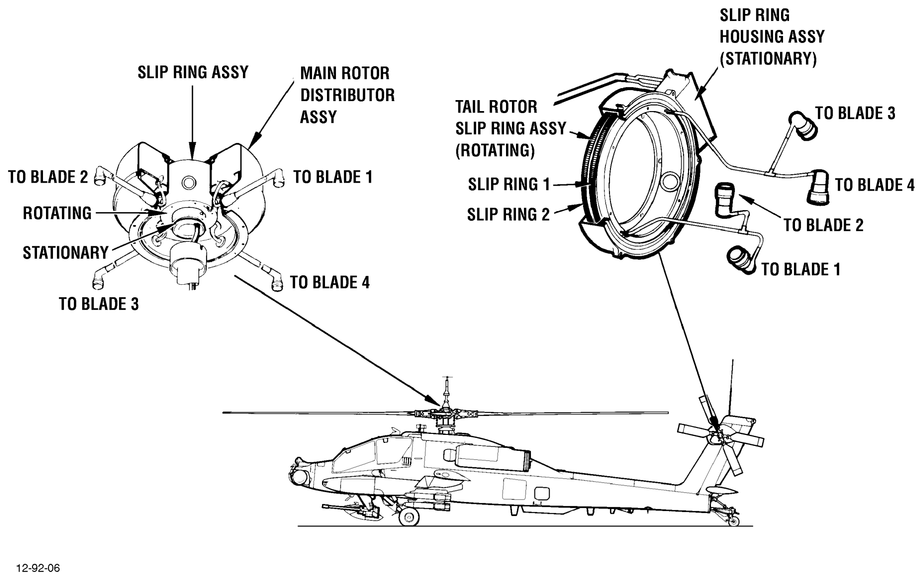
(2) With the ice detector manual override switch in the manual positions (TR, LT, or MOD), the ice detector input is a fixed level generated by the controller.

(a) TR is 1.1 volts with an "off" time of 480 seconds (J2, Pin J).

(b) LT is 2.2 volts with an "off" time of 240 seconds (J2, Pin K).

(c) MOD is 4.4 volts with an "off" time of 120 seconds (J2, Pin L).

DISTRIBUTOR AND SLIP RING ASSEMBLIES



NOTES

22. Slip ring assemblies (main and tail rotor)

a. The main rotor slip ring assembly applies "134 VDC from the blade deice controller to the main rotor distributor assembly.

b. The tail rotor slip ring assembly applies "134 VDC from the blade deice controller to the tail rotor blade deice blankets.

c. The main rotor slip ring assembly is mounted below the air data sensor on the main mast.

d. The tail rotor slip ring assembly is mounted on the tail rotor swashplate assembly.

e. Main slip ring assembly

(1) Consists of a stationary ring, two rotating slip rings, and carbon brushes.

(2) " 134 VDC from the blade deice controller is applied to the stationary ring.

(3) Carbon brushes transfer electrical power/control signals from the stationary ring to the rotating slip rings.

(4) The rotating slip rings apply power/control signals to the main rotor distributor.

f. Tail rotor slip ring assembly

(1) Consists of a stationary housing assembly, two rotating slip rings, and carbon brushes.

(2) "134 VDC from the blade deice controller, is applied to the stationary housing assembly.

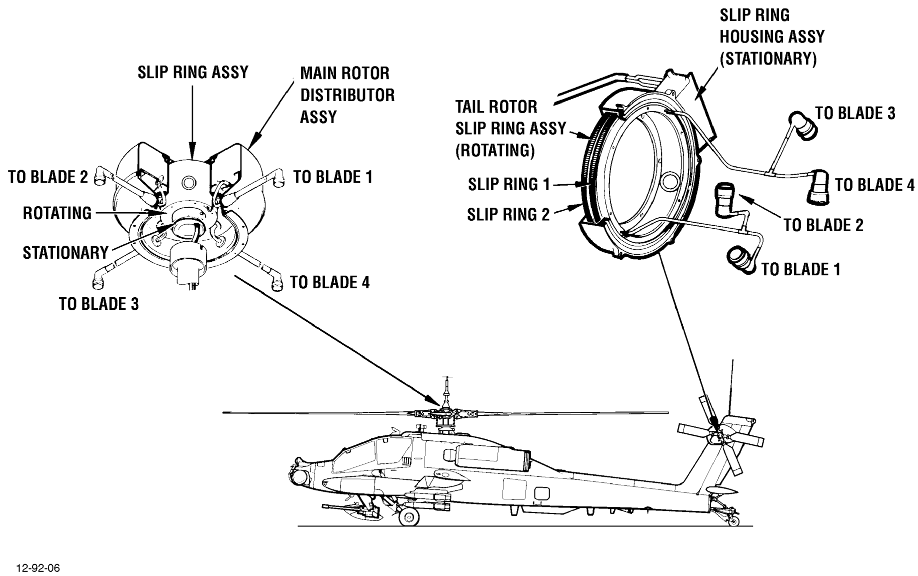
(3) Carbon brushes apply power from the stationary housing assembly to the rotating slip rings.

(4) The rotating slip rings apply electrical power to the tail rotor blade deice blankets.

g. Main rotor distributor assembly

(1) Attached to the main rotor drive plate beneath the OAS.

DISTRIBUTOR AND SLIP RING ASSEMBLIES



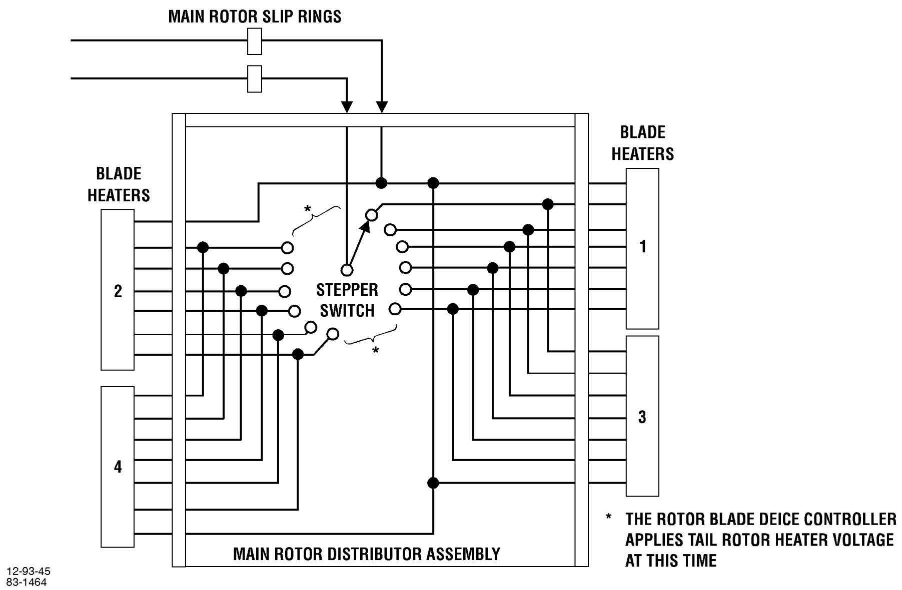
NOTES

(2) Cylindrical, environmentally sealed, cast aluminum housing containing terminal blocks, bus bars, and a solid-state switching device (stepper switch).

(3) The stepper switch controls which main rotor blades are heated and the element heating sequence (leading edge to trailing edge).

(4) Supplies and controls which main rotor blades are supplied " 134 VDC for the opposing blade element heating sequence (leading edge to trailing edge).

STEPPER SWITCH FUNCTIONAL DIAGRAM



NOTES

23. Stepper switch operation

a. With the main rotors turning and "134 VDC applied to the main rotor slip rings, -134 VDC is applied to one side of each blade heater.

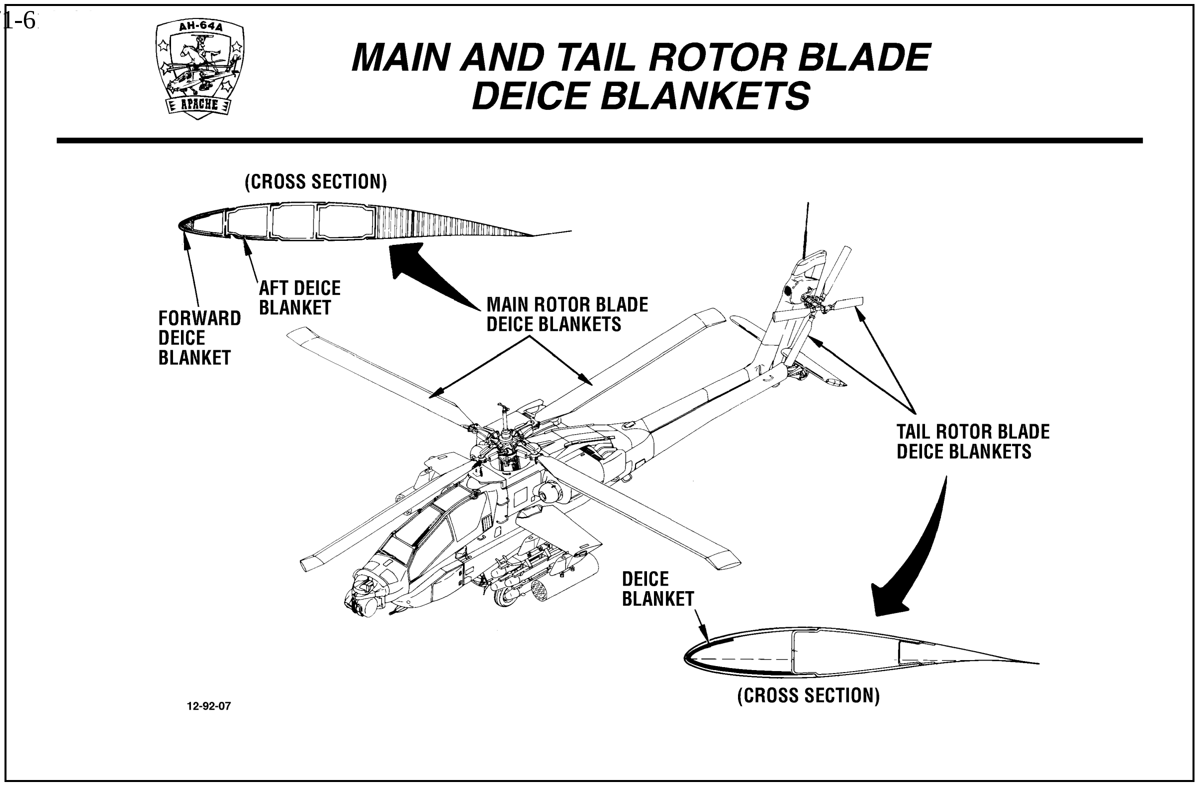
b. Sequential switching signals from the rotor blade deice controller are applied to, and actuate, the stepper switch.

c. The stepper switch routes +134 VDC sequentially to the other side of the heaters.

d. When the stepper switch is moving from blade 3 to blade 4, the deice controller applies "134 DC to the tail rotor slip rings.

e. The stepper switch is an electrical sequential function; it is not an actual mechanical switch.

071-6


AH-64A
APACHE
MAIN AND TAIL ROTOR BLADE
DEICE BLANKETS
(CROSS SECTION)
AFT DEICE
BLANKET
FORWARD
DEICE
BLANKET
MAIN ROTOR BLADE
DEICE BLANKETS
TAIL ROTOR BLADE
DEICE BLANKETS
DEICE
BLANKET
(CROSS SECTION)
12-92-07

NOTES

24. Rotor blade deice blankets (main and tail rotor)

a. Provide uniform deicing of the main and tail rotor blades.

b. Bonded internally to the top and bottom of the main and tail rotor blades.

c. Description

(1) Thermally conductive composite blankets which contain etched foil heating elements.

(2) Heating element resistance varies from 11 to 37 ohms on the main rotor blades, and from 37 to 45 ohms on the tail rotor blades.

(3) The heating elements have a positive temperature coefficient.

(4) The main rotor blades utilize two deice blankets on each blade.

(a) The forward blanket is internally bonded to the top and bottom of the leading edge and contains 4 heating elements.

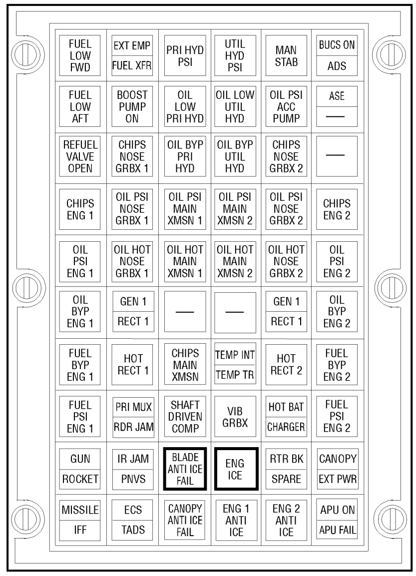
(b) The aft blanket is internally bonded to the bottom, just aft of the leading edge blanket, and contains two heating elements.

(c) The aft and forward blankets together provide heater coverage to the 10% chord on the upper surface and the 26% chord on the lower surface.

(5) The tail rotor blades have only one blanket on each blade. The blanket is bonded to the top and bottom of the leading edge and contains a single heating element. The heater coverage extends to the 10% chord on the upper surface and the 25% chord on the lower surface.

(6) The main and tail rotor blankets are bonded to the blades so that all areas are uniformly heated.

ROTOR BLADE DEICE CAUTION LIGHTS



12-93-46
83-1456

PILOTs CAUTION/WARNING/ADVISORY PANEL

NOTES

25. Rotor blade deice caution lights

a. ENG ICE caution light

(1) When illuminated, alerts the pilot that ice has been sensed by the ice detector sensor.

(2) Located on the pilot's C/W/A panel.

(3) Amber-colored light

(4) Illuminates when the ice detector sensor senses a buildup of 0.005 to 0.015 inch (0.0127 to 0.0381 centimeters) of ice.

b. BLADE ANTI-ICE FAIL caution light

(1) When illuminated, alerts the pilot to a failure of the rotor blade deice system.

(2) Located on the pilot's C/W/A panel.

(3) Amber-colored light.

(4) Operation controlled by the rotor blade deice controller.

(5) Illuminates when any one of the following components fail.

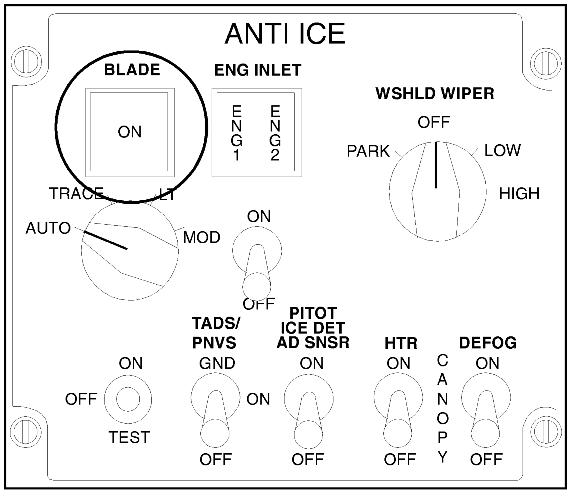
(a) Rotor blade deice controller

(b) Main rotor distributor assembly

(c) Main rotor blade heater (open or short)

(d) Tail rotor blade heater (open or short)

PILOTs ANTI-ICE CONTROL PANEL



12-93-47
83-1467

NOTES

26. BLADE ON deice advisory light

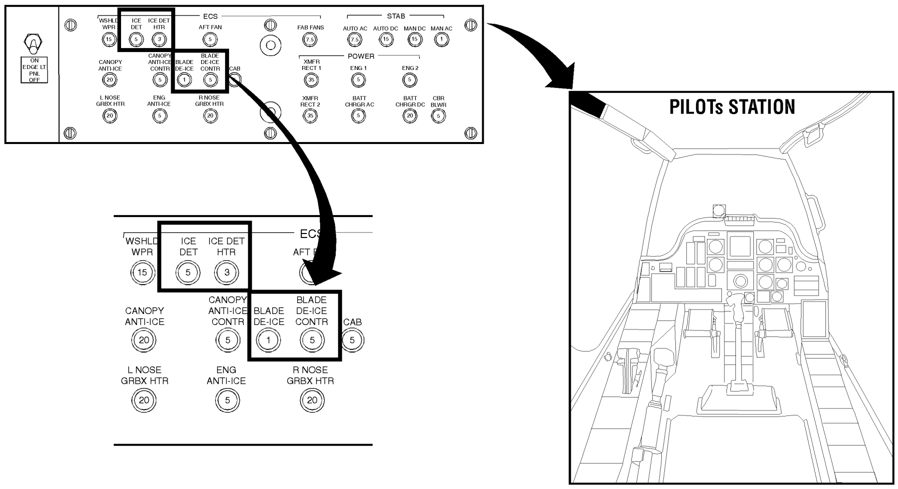
    a. Advises the pilot that the rotor blade deice system is operating.

    b. Located on the ANTI-ICE control panel in the pilot's left console.

    c. Black background with green letters.

    d. Illuminates when power is being applied to blade heating elements.

ROTOR BLADE DEICE SYSTEM CIRCUIT BREAKERS



12-93-66
86-100A

NOTES

27. Circuit protection

a. BLADE DEICE CB85

(1) Provides circuit protection for the blade deice contactor circuitry.

(2) Located on the pilot's aft overhead circuit breaker panel.

(3) Rated at 28 VDC and 1 ampere.

(4) Powered by the No. 3 DC Bus.

b. ICE DET CB68

(1) Provides circuit protection for the ice detector signal processor circuitry.

(2) Located on the pilot's aft overhead circuit breaker panel.

(3) Rated at 28 VDC and 5 amperes.

(4) Powered by the No. 3 DC Bus.

c. BLADE Deice CONTR CB83

(1) Provides circuit protection for the rotor blade deice controller circuitry.

(2) Located on the pilot's aft overhead circuit breaker panel.

(3) Rated at 28 VDC and 5 amperes.

(4) Powered by the No. 3 DC Bus.

d. ICE DET HTR CB212

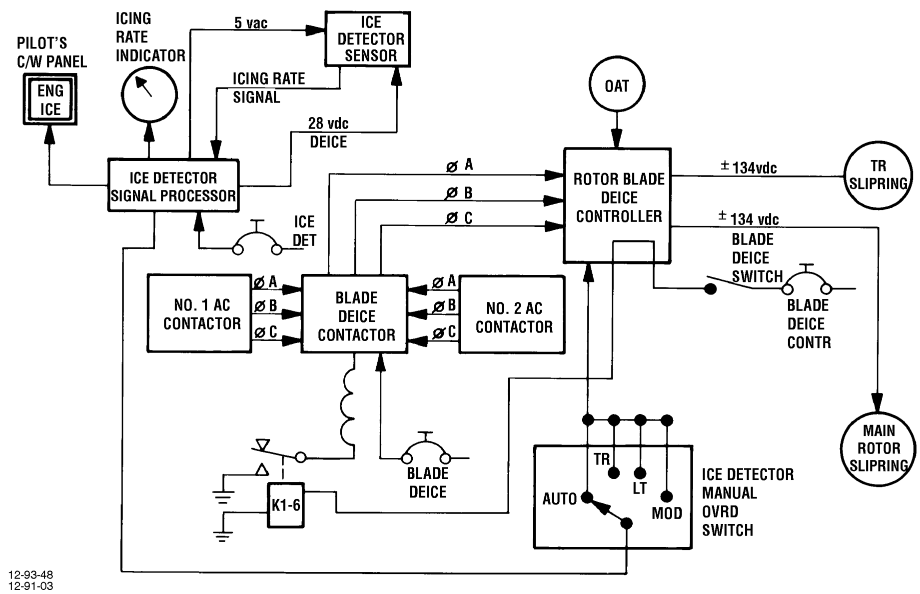
(1) Provides circuit protection for the ice detector sensor housing anti-ice circuitry.

(2) Located on the pilot's aft overhead circuit breaker panel.

(3) Rated at 115/200 VAC and 3 amps.

(4) Powered by B phase of the No. 2 AC Bus.

ROTOR BLADE DEICE ELECTRICAL DIAGRAM



NOTES

28. Deice system operation

a. Power inputs

(1) 115/200 VAC from the No. 1 and No. 2 AC generator contactors is applied to the blade deice contactor (K3).

(2) 28 VDC from the No. 3 DC Bus via the ICE DET circuit breaker, is applied to the ice detector signal processor.

(c) The rotor blade deice controller and the rotor blade deice control switch receive 28 VDC from the BLADE DEICE CONTR circuit breaker.

b. Automatic blade deicing

(1) When the ice detector sensor detects the presence of ice, its output signal frequency decreases and triggers the ice detector signal processor.

(2) The ice detector signal processor provides:

(a) 28 VDC to illuminate the ENG ICE caution light in the pilot's crewstation.

(b) A signal to the icing severity indicator, corresponding to the degree of icing.

(c) A signal (0-10 VDC) to the blade deice controller, via the ice detector manual override switch, corresponding to the degree and rate of icing.

(d) 28 VDC to cycle the ice detector sensing head heater.

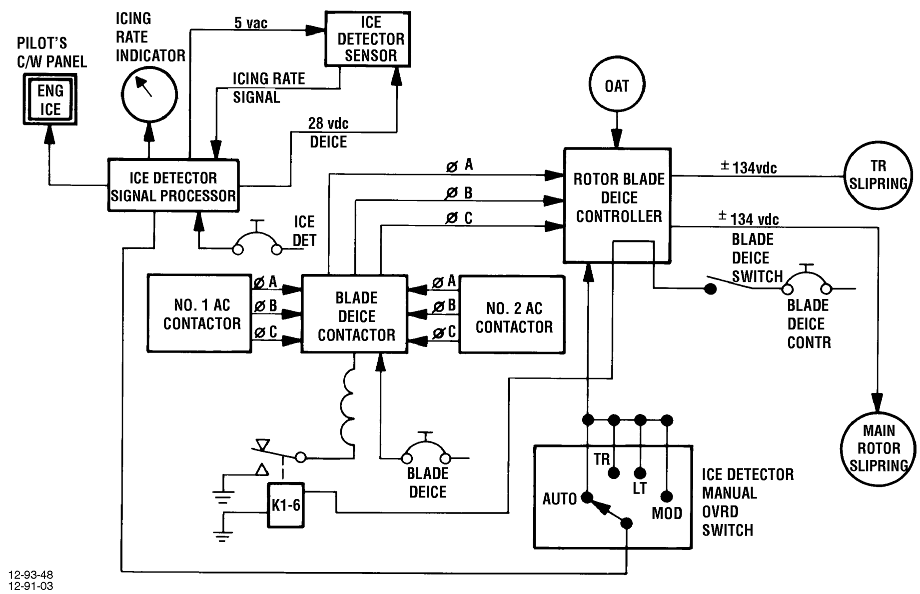
(3) Maintains this signal for 60 seconds after the sensing head has been deiced or until 0.005 inch (0.0127 centimeters) of new ice has formed, whichever is less.

(4) When the ice detector manual override switch in the auto position, system operation is initiated by placing the rotor blade deice ON-OFF-TEST switch to the ON position.

(a) 28 VDC is applied to the deice controller.

(b) The controller routes 28 VDC to the coil of relay K1-6.

ROTOR BLADE DEICE ELECTRICAL DIAGRAM



NOTES

(c) K1-6 energizes and connects a ground to the coil of the blade deice contactor (K3).

(d) K3 energizes and routes three-phase, 115/200 VAC from the No. 2 AC generator contactor to the blade deice controller.

(e) If the No. 2 generator is not operating, power is supplied by the No. 1 generator.

(f) The deice controller rectifies the three-phase, 115/200 VAC input to produce +134 VDC and -134 VDC heater voltages.

(g) The "134 VDC and the stepper switch sequential switching signals are routed to the main rotor slip rings and distributor.

(h) Each main rotor blade has six separate heaters.

(i) -134 VDC is applied to one side of each heater via the slip rings and distributor.

(j) +134 VDC is applied to the other side of the heaters sequentially by the main rotor distributor assembly stepper switch.

(k) Corresponding areas of two diametrically opposed blades (1 and 3 or 2 and 4) are heated at the same time.

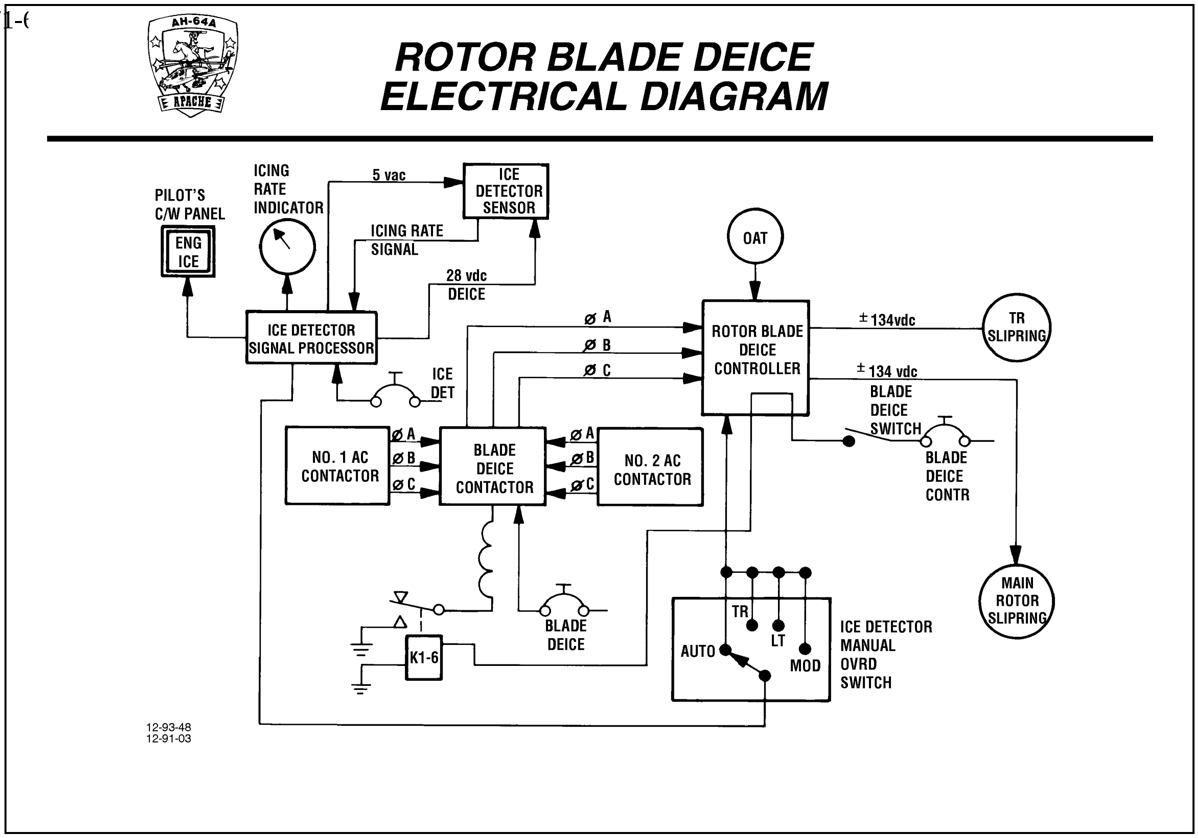
(5) For explanation purposes, main rotor blades 1 and 3 are heated first.

(a) When the two main rotor blades have had each element heated, the deice controller disconnects power from the main rotor slip ring assembly and applies it to the tail rotor slip ring assembly.

(b) Power is applied to all four tail rotor blade heaters simultaneously.

(c) When the tail rotor blades have been heated, the deice controller is disconnected power from the tail rotor slip ring assembly and apply it to the main rotor slip ring assembly.

(d) Power is now applied to the heating elements of main rotor blades 2 and 4.


AH-64A
APACHE
ROTOR BLADE DEICE
ELECTRICAL DIAGRAM
PILOT'S
C/W PANEL
ENG
ICE
ICING
RATE
INDICATOR
5 vac
ICE
DETECTOR
SENSOR
ICING RATE
SIGNAL
28 vdc
DEICE
OAT
ICE DETECTOR
SIGNAL PROCESSOR
ICE
DET
Ø A
Ø B
Ø C
ROTOR BLADE
DEICE
CONTROLLER
± 134vdc
TR
SLIPRING
± 134 vdc
BLADE
DEICE
SWITCH
BLADE
DEICE
CONTR
NO. 1 AC
CONTACTOR
BLADE
DEICE
CONTACTOR
NO. 2 AC
CONTACTOR
MAIN
ROTOR
SLIPRING
K1-6
BLADE
DEICE
TR
LT
AUTO
MOD
ICE DETECTOR
MANUAL
OVRD
SWITCH
12-93-48
12-91-03

NOTES

(e) This cycle of deice operation (1 and 3, tail rotor, 2 and 4, tail rotor, etc.) is continued for a variable time period, as determined by the blade deice controller inputs.

(f) When the ice detector sensor has been deiced, the ice detector signal processor removes 28 VDC heater voltage and prepare for another icing encounter.

(g) 60 seconds after the ice detector sensor has been deiced, if no new ice has formed, the signal processor extinguishes the ENG ICE caution light, cancel the ice detector input signal, and place the deice system in a hold mode.

c. Manual blade deicing

(1) With the ice detector manual override switch in the manual positions TR, LT, and MOD, the ice detector input is a fixed DC level generated by the controller.

(2) The controller compares this fixed input to the blade heater element resistance and the OAT sensor inputs to determine heater operating time.

(3) The BLADE (deice) ON advisory light on the pilot's ANTI-ICE control panel is illuminated whenever power is applied to the blade heaters.

d. Fault sensing

(1) Blade deice contactor

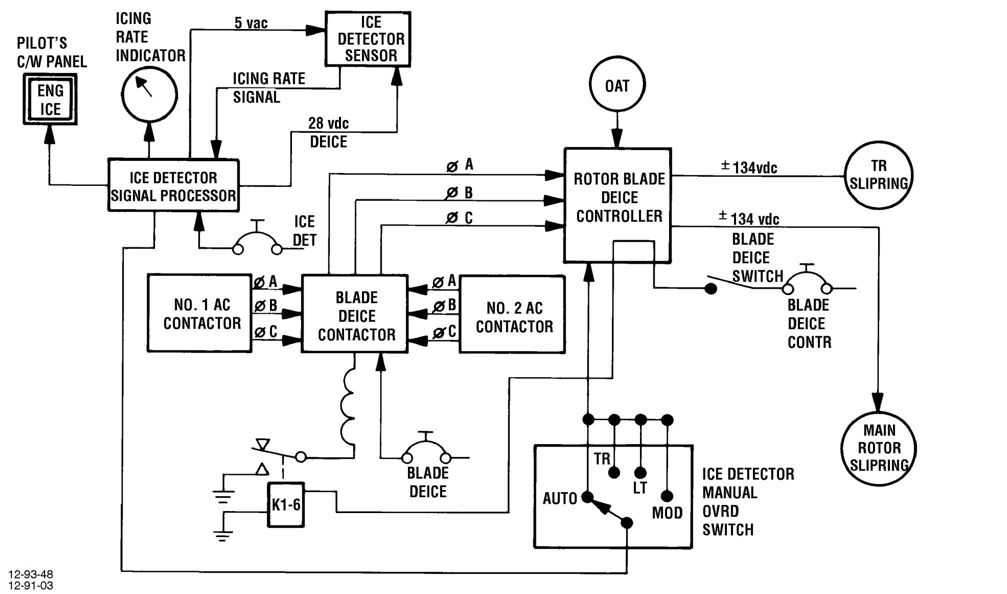
(a) If the main or tail rotor blade heater current should exceed 60 amperes for more than two seconds, the blade deice contactor current sensing and time delay circuit.

1) Energizes an overcurrent trip circuit which disconnects three-phase, 115/200 VAC from the blade deice controller.

2) Energizes a time delay circuit which trips the BLADE DEICE circuit breaker (CB85) within two seconds after AC power is disconnected from the controller.

(b) To regain rotor blade deice capabilities, the BLADE DEICE circuit breaker CB85 must be reset.

ROTOR BLADE DEICE ELECTRICAL DIAGRAM



NOTES

(2) Rotor blade deice controller

(a) The rotor blade deice controller monitors the rotor blade deice system for the following faults:

1) Rotor blade deice controller

2) Unit over-temperature

3) Heater time control circuitry failure

4) AC input voltage for under-voltage

5) AC input current for overcurrent

6) DC input voltage for under-voltage

7) Heater element

a) Ground current leakage

b) Overcurrent

c) Incorrect resistance

(b) If one or more fault conditions (except heater element overcurrent or incorrect resistance), occurs:

1) The rotor blade deice controller provides a signal to illuminate the pilot's BLADE ANTI-ICE FAIL light.

2) The controller also removes 28 VDC from the coil of the blade deice contactor relay K1-6.

3) K1-6 de-energizes and removes the ground from the coil of the blade deice contactor (K3).

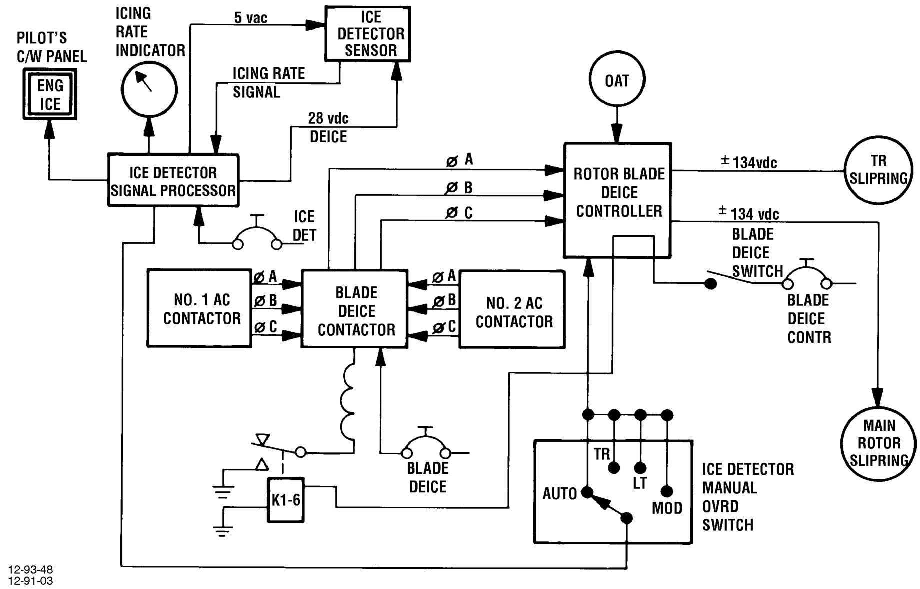
4) K3 de-energizes and disconnects three-phase, 115/200 VAC from the deice controller.

5) The deice system deactivates and the pilot's BLADE (deice) ON advisory light extinguishes.

(c) If the a heater element overcurrent or incorrect resistance condition occurs:

1) That particular heater-on time is terminated and the deicing sequence completed.

ROTOR BLADE DEICE ELECTRICAL DIAGRAM



NOTES

2) If, during the next heating sequence, the fault occurs again, that cycle of the sequence is overridden permanently (until the system is turned off), which permits the remainder of the deicing system to continue to operate.

e. System testing

(1) System test shall not be conducted with an OAT greater than 25EC.

(2) Self-test mode shall not occur at less than 10-minute intervals to allow for blade cool down.

(3) Placing the rotor blade deice ON-OFF-TEST switch in the TEST position routes 28 VDC to the ON/TEST input of the deice controller.

(4) In response to this input, the controller processes the blade deice system through one full cycle (approximately two seconds).

(5) Releasing ON-OFF-TEST switch to the OFF position prevents the system from continuing to cycle.

(6) The pilot's blade ANTI-ICE light illuminates in the event of a failure of one or more of the following components.

(a) Rotor blade deice controller

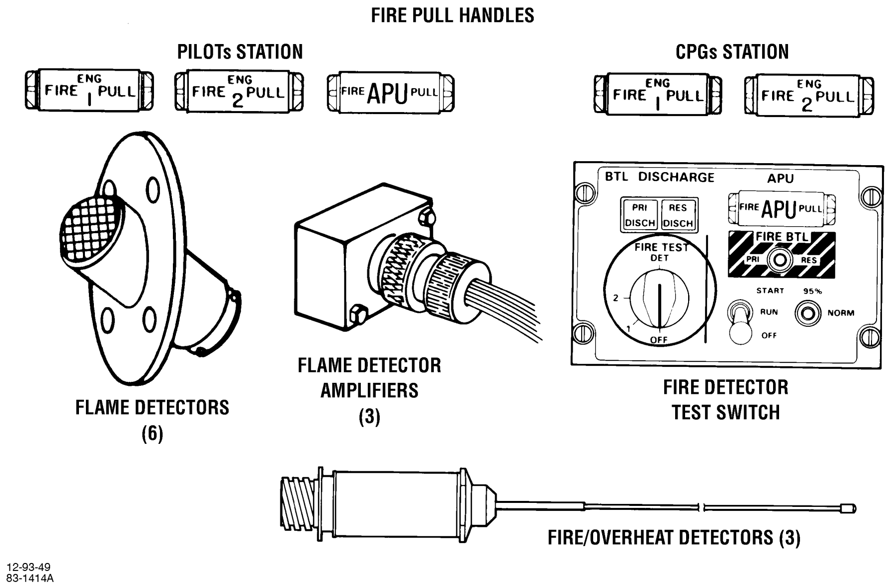
(b) Main rotor distributor assembly

(c) Main rotor blade heating element(s)

(d) Tail rotor blade heating elements

(7) The rotor blade deice system is also monitored by the aircraft's FD/LS.

FIRE DETECTION SYSTEM MAJOR COMPONENTS



NOTES

A. Fire detection and extinguishing systems

1. The fire detection system gives a visual alarm for both crew-stations in the event of a fire in either the engine compartment, APU compartment, or main transmission deck area.

2. The fire extinguishing system extinguishes fire in either the engine or APU compartments.

3. The fire detection and extinguishing system components are located in the crew-stations, the aft equipment bay, main transmission deck, and the engine compartments.

4. The fire detection system will:

   a. Produce an alarm signal when exposed to radiant (non-thermal) energy emitted by a flame.

   b. Not produce an alarm when exposed to sources of radiation (such as sunlight, artificial lighting, or other ambient light) or hot engine parts.

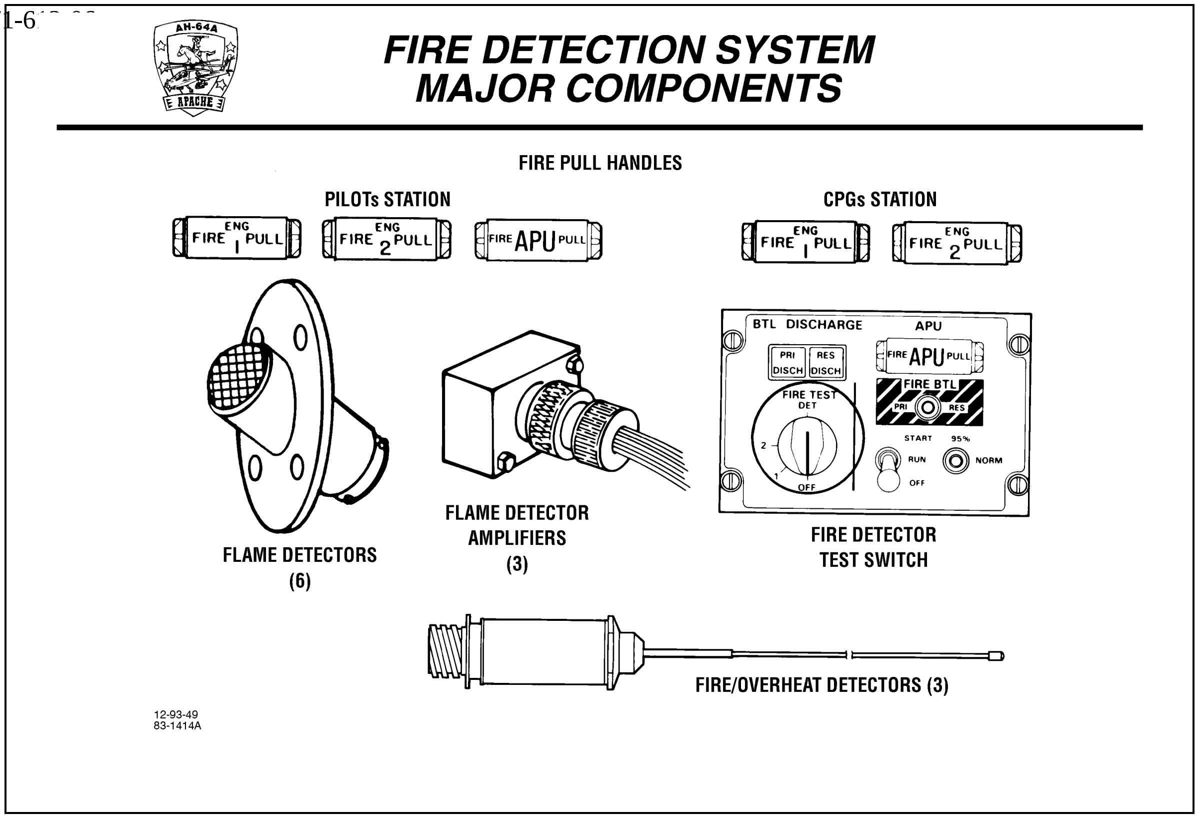
   c. Indicate fire within 5 seconds after exposure to flame.

   d. Reset to signal a re-ignition within 5 seconds after signal clearance without a manual reset.

5. The fire extinguishing system is:

   a. Manually armed and electrically activated.

   b. Capable of discharging an extinguishing agent into a selected compartment within 0.5 second following activation.


AH-64A
APACHE
FIRE DETECTION SYSTEM
MAJOR COMPONENTS
FIRE PULL HANDLES
PILOTs STATION
CPGs STATION
FIRE ENG 1 PULL
FIRE ENG 2 PULL
FIRE APU PULL
FLAME DETECTORS
(6)
FLAME DETECTOR
AMPLIFIERS
(3)
BTL DISCHARGE
APU
PRI DISCH
RES DISCH
FIRE BTL
PRI
RES
FIRE TEST
DET
2
1
OFF
START
95%
RUN
OFF
NORM
FIRE DETECTOR
TEST SWITCH
FIRE/OVERHEAT DETECTORS (3)
12-93-49
83-1414A

NOTES

6. Fire detection system major components

   a. Pilot crewstation fire pull handles (3)

   b. CPG's crewstation fire pull handles (2)

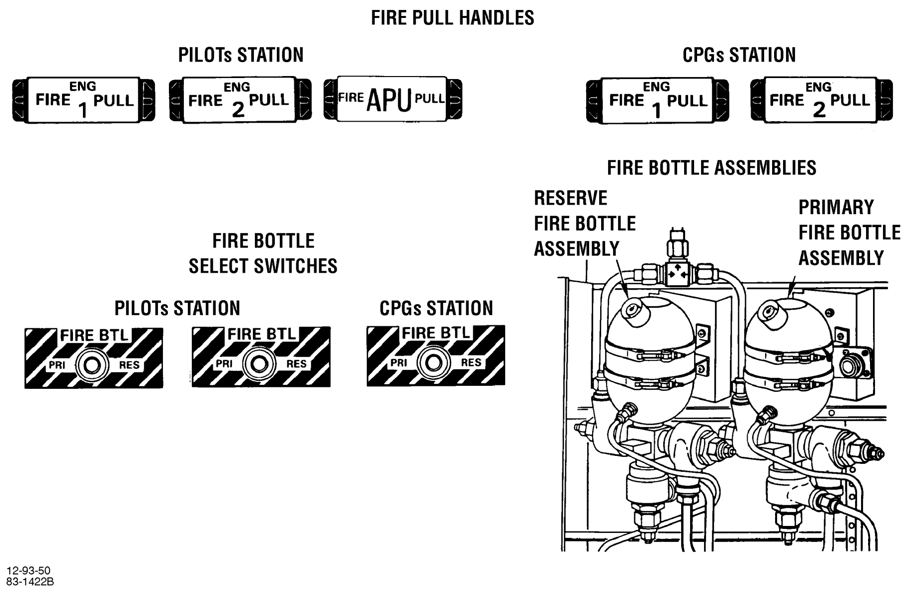
   c. Flame detectors (6)

   d. Flame detector amplifiers (3)

   e. Fire test detector (DET) test switch

   f. Fire/overheat detectors (3)

FIRE EXTINGUISHING SYSTEM MAJOR COMPONENTS



NOTES

7. Fire extinguishing system major components

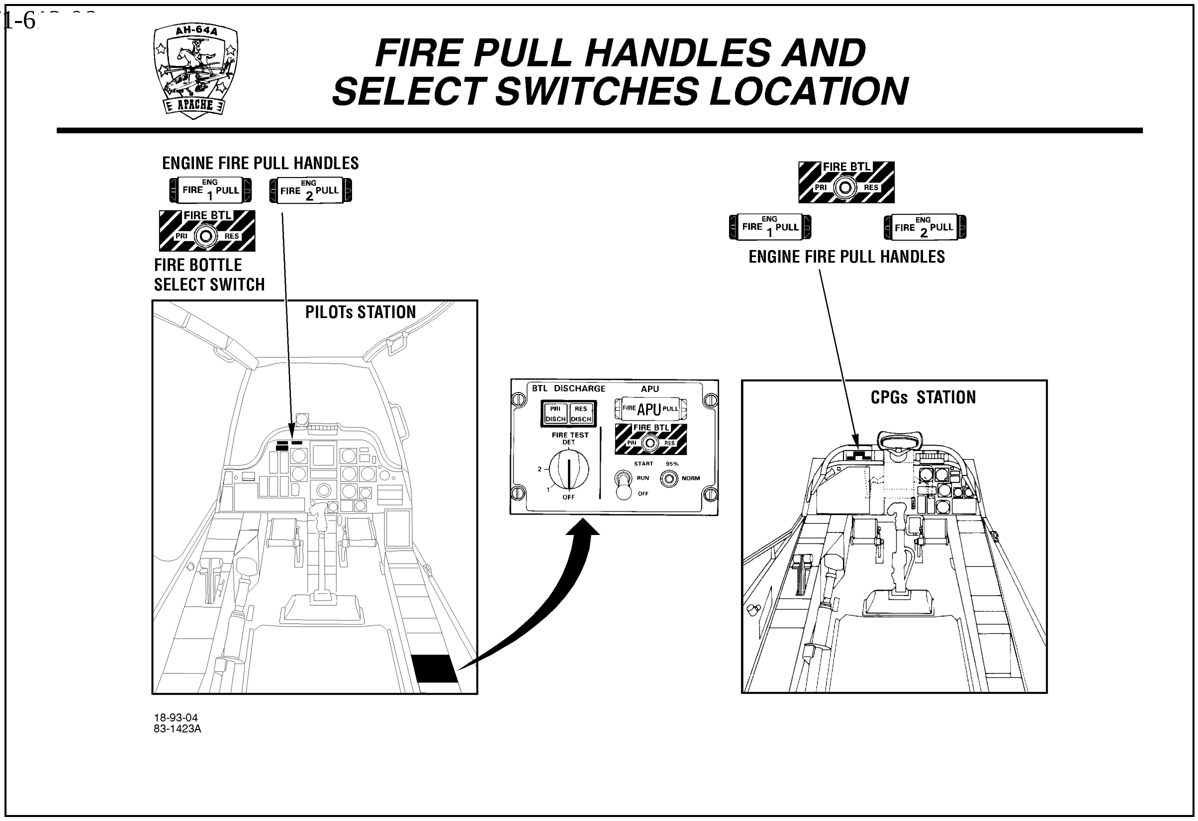
   a. Pilot's crewstation fire pull handles (3)

   b. CPG's crewstation fire pull handles (2)

   c. Pilot's crewstation fire bottle select switches (2)

   d. CPG's crewstation fire bottle select switch

   e. Primary and reserve fire bottle assemblies


AH-64A
APACHE
FIRE PULL HANDLES AND
SELECT SWITCHES LOCATION
ENGINE FIRE PULL HANDLES
FIRE ENG 1 PULL
FIRE ENG 2 PULL
FIRE BTL
PRI
RES
FIRE BOTTLE
SELECT SWITCH
PILOTs STATION
BTL DISCHARGE
APU
PRI DISCH
RES DISCH
FIRE APU PULL
FIRE TEST
DET
OFF
START
95%
RUN
NORM
CPGs STATION
18-93-04
83-1423A

NOTES

8. Fire detection component location

   a. No. 1 and No. 2 fire pull handle is located on the upper left portion of both the pilot and CPG's instrument panels.

   b. The APU fire pull handle is located on the BTL discharge/APU control panel on the pilot's right console.

   c. Fire pull handles, when illuminated, warn the crew that a fire exists in the corresponding engine compartment.

   d. When fire handle is pulled, four events occur.

      (1) Fuel is shutoff to the affected engine.

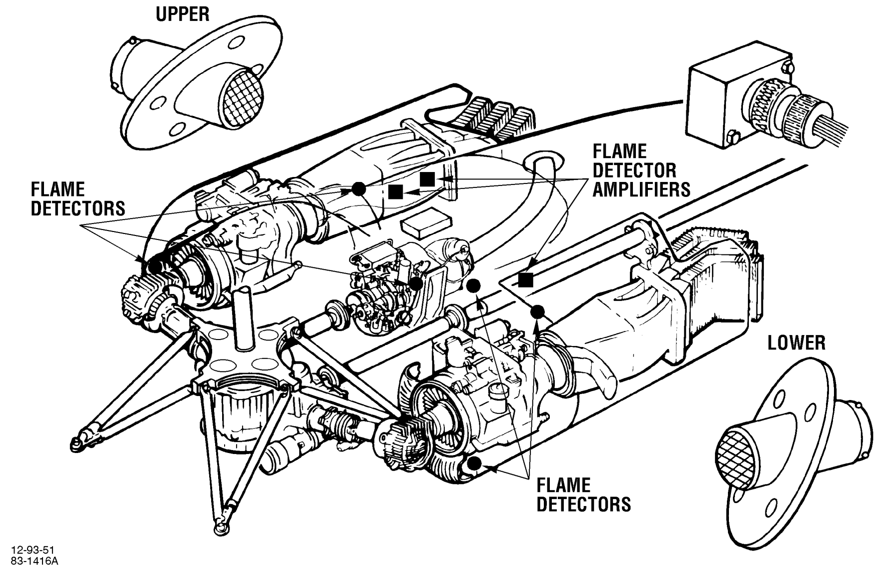
      (2) Engine cooling louvers to the affected engine close (not applicable to the APU).

      (3) The appropriate squib firing circuit is armed.

      (4) The ENCU is shut off (not applicable to the APU).

   e. The fire pull handles have red filtered lenses with two lamps in each handle.

FLAME DETECTOR AND AMPLIFIER LOCATIONS



NOTES

9. Flame detectors

   a. Generate a signal when a flame is detected in the respective engine compartment. Each engine compartment has one detector in the lower forward, outboard position and one in the upper aft, inboard position.

   b. The flame detectors are optical sensing devices which use hermetically sealed and balanced photocells to produce an electrical signal when a flame is detected.

10. Flame detector amplifiers

   a. Amplify flame detector warning signals to control the fire pull handle lamps.

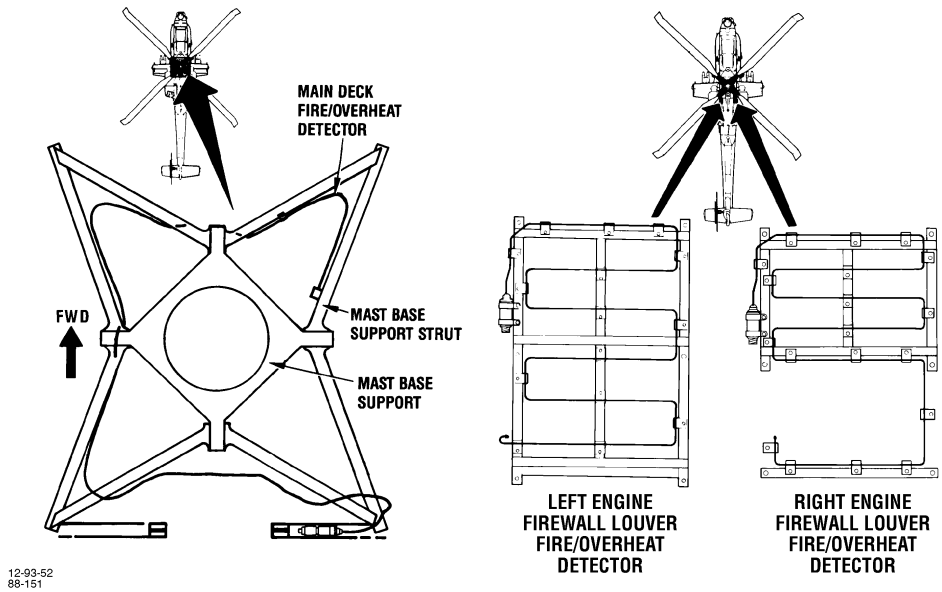
      (1) The No. 1 fire detector amplifier is mounted on the inboard side of the No. 1 engine firewall, above the fire bottles, in the aft equipment bay.

      (2) The No. 2 fire detector amplifier is mounted on the inboard side of the No. 2 engine firewall, above the APU enclosure, forward of the APU flame detector amplifier, in the aft equipment bay.

   b. Compact [1.80 x 1.60 x 2.20 inches (4.5 x 4.0 x 5.5 centimeters)], lightweight (0.3 pounds [0.13 kilograms]), solid-state LRU with one quick disconnect receptacle for power and control connection.

   c. The flame detector amplifiers control circuitry for the ENG FIRE PULL handle warning lights.

FIRE/OVERHEAT DETECTORS



NOTES

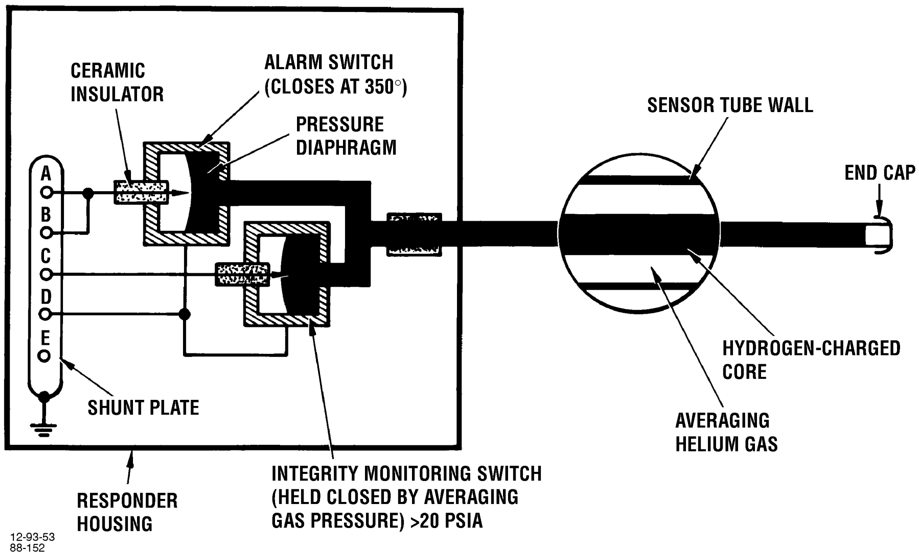
11. Fire/overheat detectors

    a. Provide a means of alerting the crew in case of a fire or overheat condition in the aft and main deck areas.

    b. One temperature sensor is mounted on the mast base support strut.

    c. One temperature sensor is mounted on both the left and right main transmission oil cooler louvers.

FIRE/OVERHEAT DETECTOR OPERATION



NOTES

12. Operation/description of fire/overheat detectors

   a. The temperature sensor is a sealed unit consisting of an alarm switch, an integrity monitoring switch, and a hydrogen-charged core surrounded by helium gas.

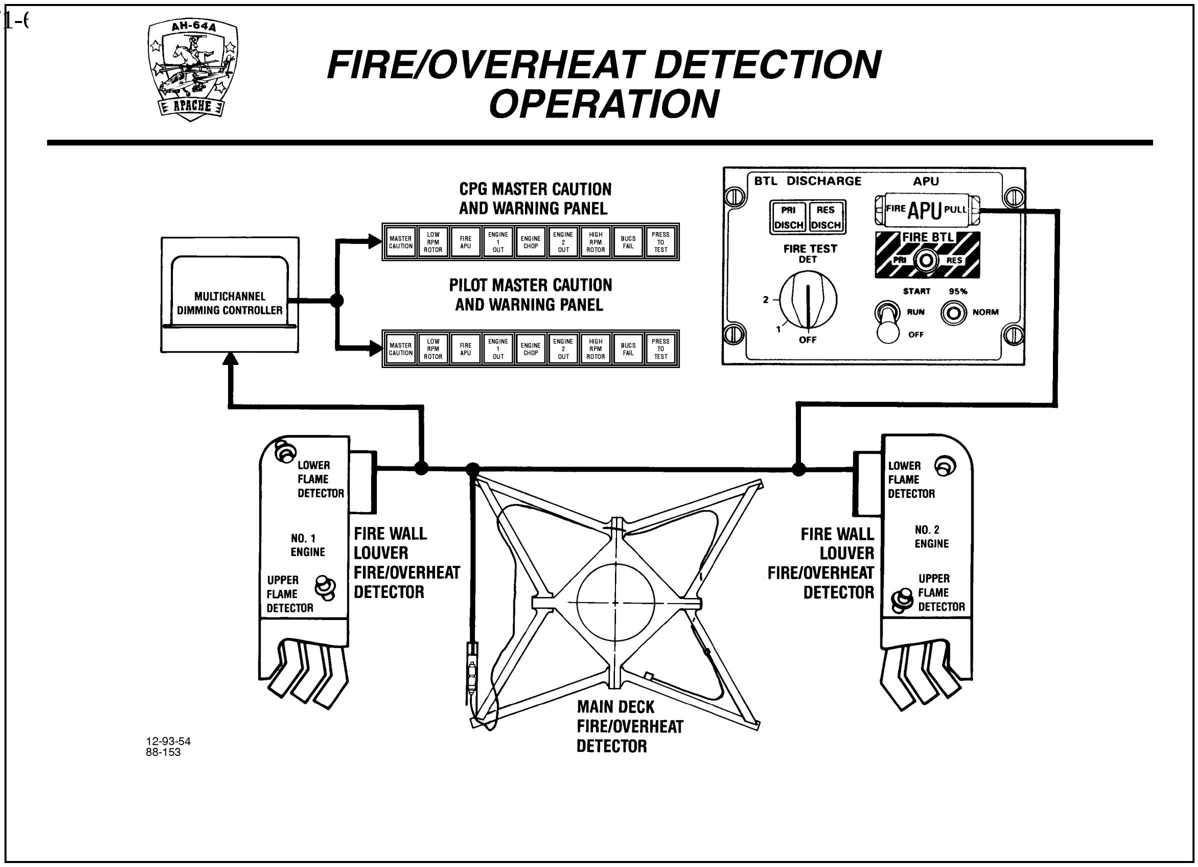
   b. The alarm switch is a normally open switch that is controlled by a pressure diaphragm.

   c. As the temperature increases, pressure in the tube and pressure in the diaphragm increases.

   d. When the pressure reaches approximately 40 pounds per square inch absolute (PSIA) (275.8 kPa) at 350EF (177EC), the switch closes. (1 PSIA equals approximately 6.895 kPa. PSIA is the absolute, thermodynamic pressure measured by the number of pounds-force exerted on an area of 1 square inch. Abbreviated lb/in.^{2}, psia.)

   e. The integrity monitoring switch is held closed by the normal pressure (approximately 20 PSIA, 137.9 kPa) in the sensor tube. If the tube breaks, the pressure bleeds off, and the switch opens.

   f. When the switch is open, the fire detector system test indicates a malfunction.


AH-64A
APACHE
FIRE/OVERHEAT DETECTION
OPERATION
CPG MASTER CAUTION
AND WARNING PANEL
PILOT MASTER CAUTION
AND WARNING PANEL
MULTICHANNEL
DIMMING CONTROLLER
BTL DISCHARGE
APU
PRI DISCH
RES DISCH
FIRE APU PULL
FIRE BTL
PRI
RES
FIRE TEST
DET
2
1
OFF
START
95%
RUN
NORM
OFF
LOWER
FLAME
DETECTOR
NO. 1
ENGINE
UPPER
FLAME
DETECTOR
FIRE WALL
LOUVER
FIRE/OVERHEAT
DETECTOR
NO. 2
ENGINE
MAIN DECK
FIRE/OVERHEAT
DETECTOR
12-93-54
88-153

NOTES

13. Fire/overheat detection operation

a. Overheat condition

(1) If the right and/or left engine firewall louver or main deck fire/overheat detector senses an overheat condition (temperature $350EF), the alarm switch on the overheat detector closes.

(2) The closed alarm switch provides a path to ground that:

(a) Illuminates the APU fire handle.

(b) Causes the multi-channel dimmer control to illuminate the pilot's and CPG's FIRE APU master caution lights.

(3) When the fire/overheat detector senses that temperature is < 350EF, the alarm switch opens.

(a) The illuminated fire handle extinguishes.

(b) The pilot's and GPG's FIRE APU master caution lights extinguish.

(c) The fire/overheat detectors will respond to another overheat condition if it occurs.

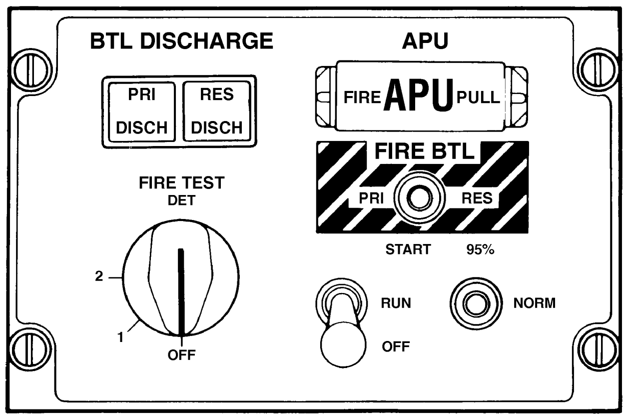
b. Test condition

(1) During a fire detector test, 28 VDC, from the FIRE DETR APU circuit breaker (CB 11), is applied through the fire detector test switch to the fire overheat detectors.

(2) If the integrity monitoring switch on the overheat detector is closed (indicating the overheat detector's integrity is intact), the FIRE APU PULL handle and the FIRE APU master caution light illuminate. (If none of the other components of the APU fire detection system are inoperative.)

(3) If the integrity monitoring switch on the overheat detector is open (indicating the overheat detector's integrity is not intact), the FIRE APU PULL handle and the FIRE APU master caution light do not illuminate.

BTL DISCHARGE/APU CONTROL PANEL



12-93-68
83-1417

NOTES

14. Fire detector (DET) test switch

a. Allows the pilot to perform an operational test of the engine fire detection circuitry and components.

b. Located on the BTL DISCHARGE/APU control panel on the pilot's right console.

c. Only the pilot has advisory lights showing which of two fire bottles has been discharged.

d. A four position, momentary contact, rotary switch that is spring-loaded to the OFF position.

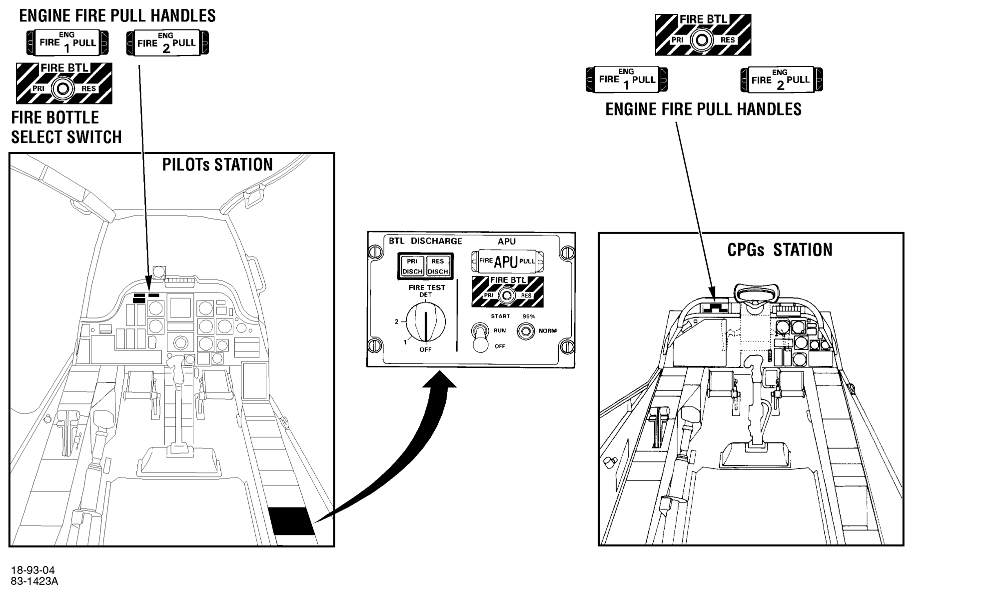
(1) OFF - system is off.

(2) 1 - tests the upper detector circuits and components and the left and right transmission oil cooler louver overheat detectors. When the test is initiated: the ENG 1 and ENG 2 FIRE PULL handles in both crew stations illuminate, the FIRE APU master caution light in both crew stations illuminates, and the FIRE APU PULL handle in the pilot's station illuminates. Illumination of all FIRE PULL handles and caution lights indicates the system and components are functioning properly.

(3) 2 - tests the lower detector circuits and components and the main deck overheat detectors. When the test is initiated: the ENG 1 and ENG 2 FIRE PULL handles in both crew stations illuminate, the FIRE APU master caution light in both crew stations illuminates, and the FIRE APU PULL handle in the pilot's station illuminates. Illumination of all FIRE PULL handles and caution lights indicates the system and components are functioning properly.

(4) A fourth position on the switch is neither marked nor used.

FIRE PULL HANDLES AND SELECT SWITCHES LOCATION



NOTES

B. Fire extinguishing components

1. Fire pull handles

a. When pulled, the fire pull handles:

(1) Energize the respective fuel cross feed valve to shut off fuel to the engine.

(2) Energize the respective louver actuator shutoff valves to close the engine louvers and limit engine compartment airflow.

(3) Energize the ENCU relay to close the ENCU shutoff valve; this ensures maximum pressurized air for the engine louver system.

(4) Arm the respective FIRE BTL select switch.

b. Contain a four-pole, double-throw switch that is actuated when the handles are pulled.

2. FIRE BTL select switches

a. When armed, allow the flight crew to discharge the primary or reserve fire bottle into a selected engine or APU compartment.

b. An engine FIRE BTL select switch is located in each crewstation on the top left center of the instrument panel.

c. The APU FIRE BTL select switch is located on the BTL DISCHARGE/APU control panel in the pilot's right console.

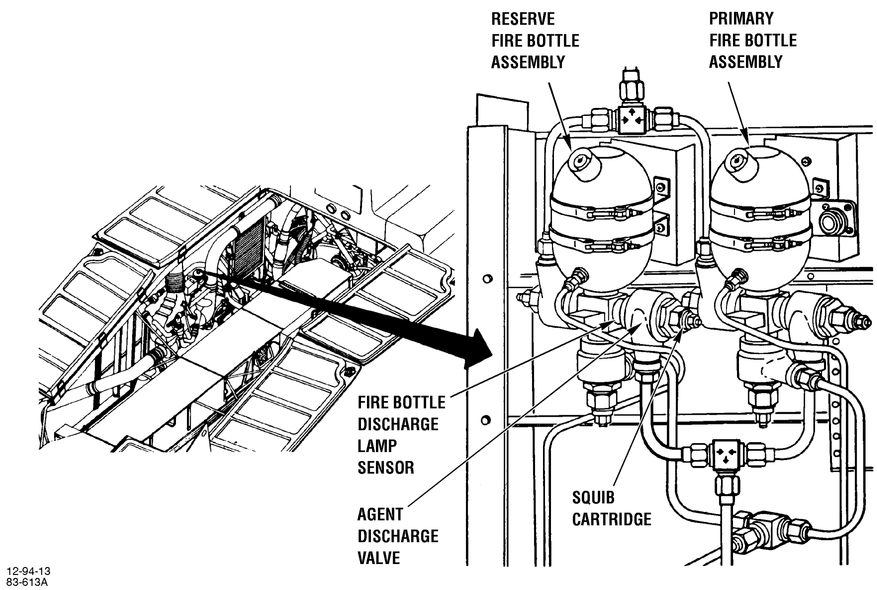
d. The switches are a single-pole, double-throw, three-position toggle switch.

(1) PRI - primary position selects primary fire bottle.

(2) RES - reserve position selects reserve fire bottle.

(3) Center position is spring-loaded OFF.

FIRE BOTTLE ASSEMBLIES



NOTES

3. Fire bottle assemblies

   a. Provide a source of pressurized chemical fire extinguishing agent for the engine and APU compartments.

   b. Two fire bottle assemblies are located in the aft equipment bay, mounted on the left firewall.

   c. The forward assembly is the primary (discharge) fire bottle and the aft assembly is the reserve fire bottle.

   d. The fire bottles are inspected during phase maintenance inspections 2 and 4 for dents and mounting security. Container charge pressure is checked. Cartridges, fittings, and valves are inspected for cracks, distortion, and security.

   e. Description

      (1) Compact, lightweight (4.38 pounds), corrosion-resistant steel container.

      (2) Each fire bottle is filled with 1.5 pounds (0.7 kilograms) of Bromotrifluoromethane ($CBrF_3$) HALON 1301 (chemical family name is halocarbon) pressurized by nitrogen to 600 psi (4137 kPa).

WARNING

Exposure to high concentrations of fire extinguishing agent or decomposition products should be avoided. The gas should not be allowed to contact the skin; it could cause frostbite or low temperature burns. If agent is released evacuate area. Ventilate enclosed areas. If agent comes in contact with skin, seek medical help immediately.

   f. Each fire bottle contains three agent discharge valves.

      (1) No. 1 engine discharge valve

      (2) No. 2 engine discharge valve

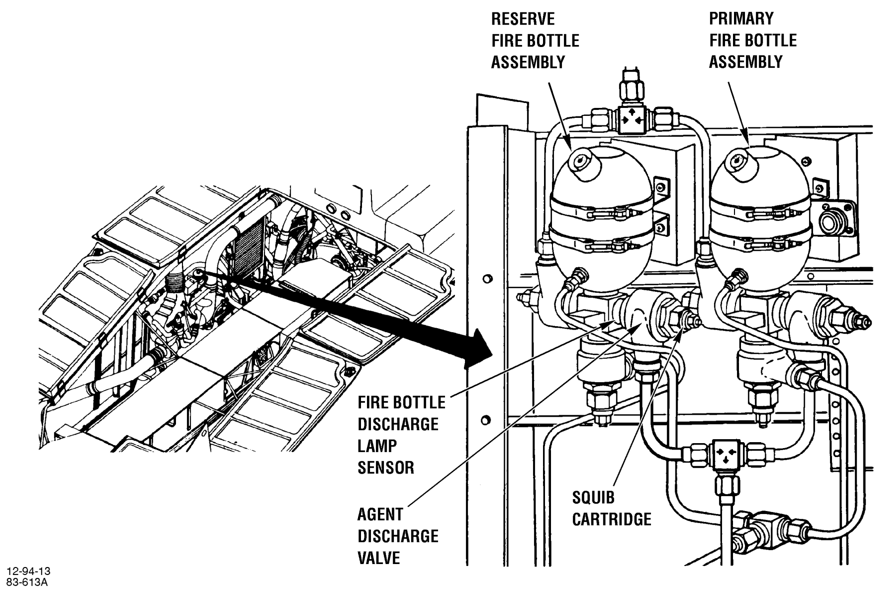
      (3) APU discharge valve

   g. Each agent discharge valve contains:

      (1) An electrically actuated explosive device (squib cartridge) used to release the extinguishing agent into its respective plumbing system.

      (2) A fire bottle discharge lamp sensor which, when actuated, causes the respective BTL DISCHARGE lamp (PRI DISCH or RES DISCH) to illuminate.

FIRE BOTTLE ASSEMBLIES



NOTES

C. Halon 1301 description, characteristics, physical properties, emergency and first aid procedures

1. Halon 1301 Bromotrifluoromethane ($CBrF_3$)

   a. Fire suppression agent implemented in the mid 1950's.

   b. Refrigerant No. 13B1.

   c. Department of Transportation DOT shipping information - [Compressed gas, n.o.s. (Bromotrifluoromethane) non-flammable gas UN 1956].

   d. Export information - (Bromotrifluoromethane, non-flammable gas, UN 1009, IMO class 2.2).

2. Characteristics

   a. Very low toxicity (as compared to several more toxic fire extinguishing agents currently in use)

   b. Good weight and volume efficiency

   c. No clean up required

   d. Non-corrosive

   e. Electrically non-conductive

   f. Very stable compound/easily stored

   g. Excellent low temperature performance

   h. Extraordinary ease of distribution (three-dimensional dispersion)

3. Physical Properties

   a. Boiling Point at 1 atmosphere pressure (sea level) is -72.4EF (-58EC)

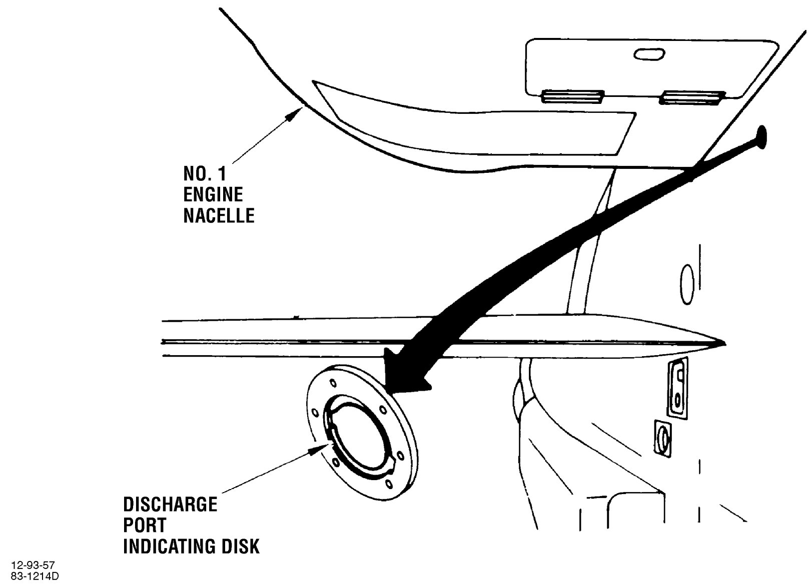
   b. Molecular weight of 148.93

   c. Freezing Point is - 270.4EF (-168EC)

   d. Atmospheric lifetime is 110 years

   e. Allowable exposure Occupational Safety Health Administration (OSHA) Permissible Exposure Limit (PEL) concentration is 1,000 parts per million

DISCHARGE INDICATOR



NOTES

D. Discharge indicator

1. Each fire bottle has a pressure relief/charge valve that is connected by 0.25-inch (0.6 centimeters) tubing to a discharge indicator.

2. The discharge indicator gives a visual indication of fire bottle discharge due to excessive temperature.

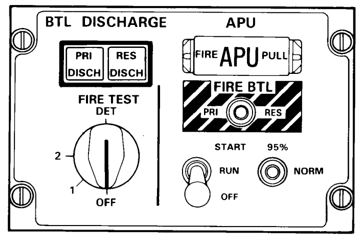
3. Located on the left side of the fuselage beneath the engine compartment.

4. 1**3** inches (3.1 centimeters) in diameter; yellow in color.

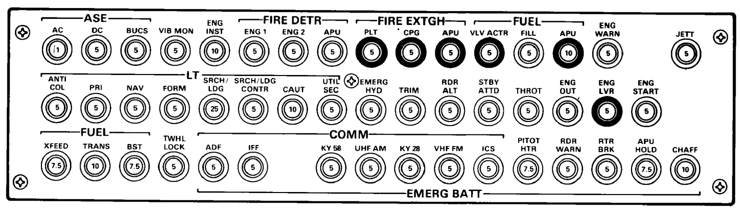
5. If the temperature in either fire bottle reaches 215°F to 226°F (102°C to 107°C), the respective pressure relief valve is forced open. The bottle discharges the agent through the tubing and eject the discharge indicator.

6. The discharge indicator does not identify which fire bottle has discharged or if both have discharged. A visual inspection of the fire bottle pressure gages is required to determine which container has discharged.

FIRE EXTINGUISHING SYSTEM ADVISORY LAMPS AND CIRCUIT BREAKERS



BTL DISCHARGE/APU
CONTROL PANEL



PILOTs CENTER OVERHEAD CB PANEL

12-93-58
86-91

NOTES

E. Fire bottle assemblies

1. Provide a source of pressurized chemical fire extinguishing agent for the engine and APU compartments.

2. Fire BTL DISCHARGE advisory lamps

   a. Give a visual indication to the pilot of which fire bottle has been discharged.

   b. Located on the BTL DISCHARGE/APU control panel in the pilot's right console.

   c. Two lamp assemblies mounted together (PRI DISCH on the left side and RES DISCH on the right).

   d. Black background with green letters.

   e. When illuminated, indicates that the respective fire bottle has been discharged.

   f. If the fire bottle has discharged through the pressure relief valve due to temperature, the FIRE BTL DISCHARGE advisory lamp will not illuminate.

3. Circuit protection FIRE EXTGH PLT, CPG, and APU circuit breakers (CB25, CB15, and CB26)

   a. Provides circuit protection for the No. 1 engine, No. 2 engine, and APU fire extinguishing circuits, respectively.

   b. Located on the pilot's center overhead circuit breaker panel.

   c. Rated at 28 VDC and 5 amperes.

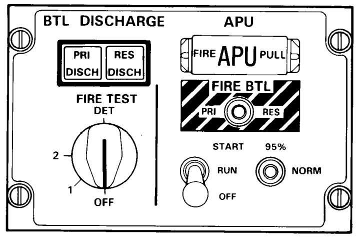
   d. Powered by the emergency DC Bus.

      (1) CB25 supplies 28 VDC to the pilot's engine FIRE BTL select switch.

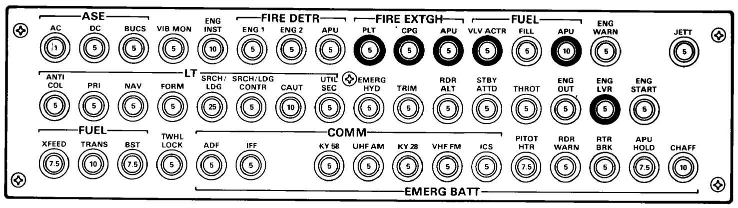
      (2) CB15 supplies 28 VDC to the CPG engine FIRE BTL select switch and BTL DISCHARGE lamp relays A138 K1 and K2.

      (3) CB26 supplies 24/28 VDC to the APU FIRE BTL select switch.

FIRE EXTINGUISHING SYSTEM ADVISORY LAMPS AND CIRCUIT BREAKERS



BTL DISCHARGE/APU CONTROL PANEL



PILOTs CENTER OVERHEAD CB PANEL

12-93-58
86-91

NOTES

4. FUEL APU (CB9) and FUEL VLV ACTR (CB14)

   a. Provide circuit protection for the APU fuel shutoff valve, and the right and left fuel cross feed shutoff valves.

   b. Located on the pilot's center overhead circuit breaker panel.

   c. Rated at 28 VDC, 10 amperes and 5 amperes respectively.

   d. Powered by the emergency DC Bus.

   e. CB9 supplies 28 VDC for the APU fuel shutoff valve.

   f. CB14 supplies 28 VDC for the left and right fuel cross feed shutoff valves.

5. ENG LVR (CB16)

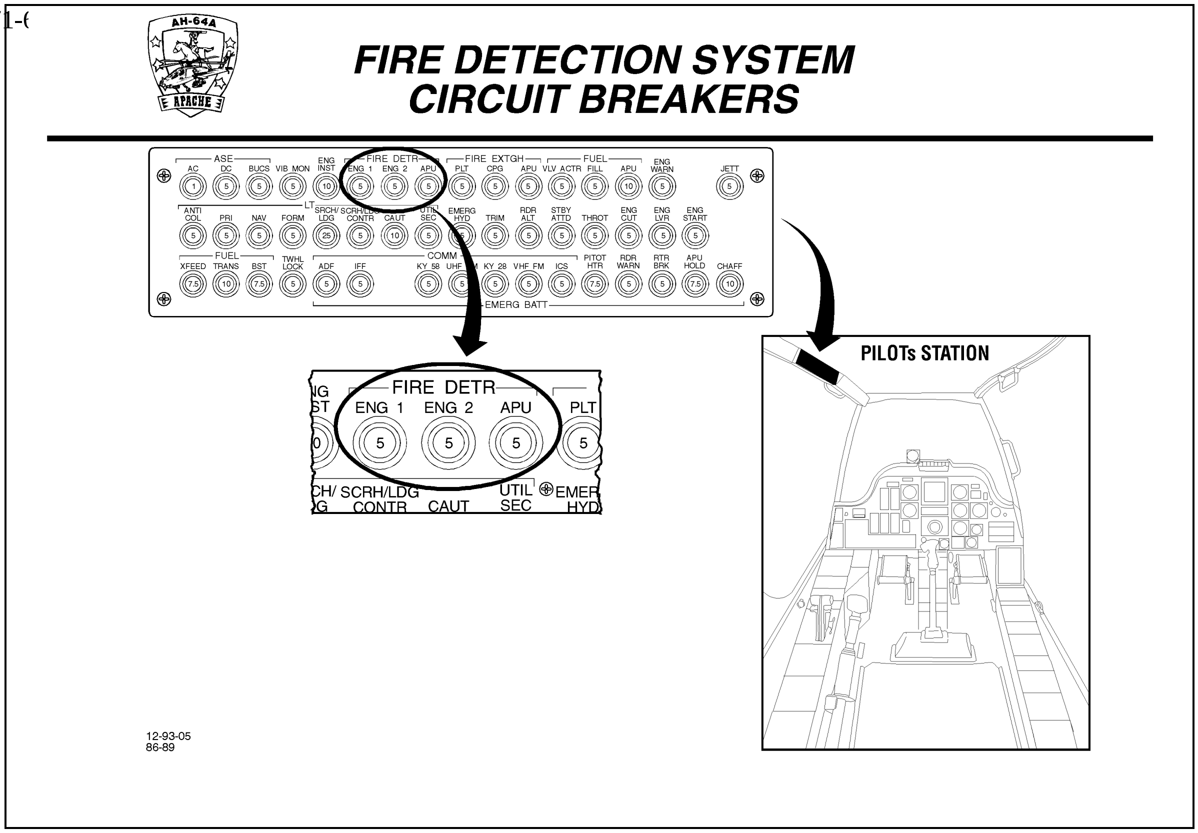
   a. Provides circuit protection for the left and right engine louver actuator circuits.

   b. Located on the pilot's center overhead circuit breaker panel.

   c. Rated at 28 VDC and 5 amperes.

   d. Powered by the emergency DC Bus.

   e. Supplies 28 VDC for the left and right engine louver actuator shutoff valves.


AH-64A
APACHE
FIRE DETECTION SYSTEM
CIRCUIT BREAKERS
FIRE DETR
ENG 1
ENG 2
APU
5
5
5
SCRH/LDG
CONTR
CAUT
UTIL
SEC
PLT
PILOTs STATION
12-93-05
86-89

NOTES

6. FIRE DETR APU (CB11), FIRE DETR ENG 1 (CB12) and FIRE DETR ENG 2 (CB13) circuit breakers

   a. Provide circuit protection for the respective fire detection systems.

   b. Located on the pilot's center overhead circuit breaker panel.

   c. Rated at 28 VDC and 5 amperes

   d. Powered by the emergency DC Bus

   e. CB11 (FIRE DETR APU) supplies 28 VDC to:

      (1) APU forward and aft flame detectors.

      (2) APU flame detector amplifier.

      (3) APU FIRE PULL handle warning lamps.

   f. CB12 (FIRE DETR ENG 1) supplies 28 VDC to:

      (1) Fire detector test switch.

      (2) Engine 1 flame detectors.

      (3) Engine 1 flame detector amplifiers.

      (4) Multichannel dimming controller.

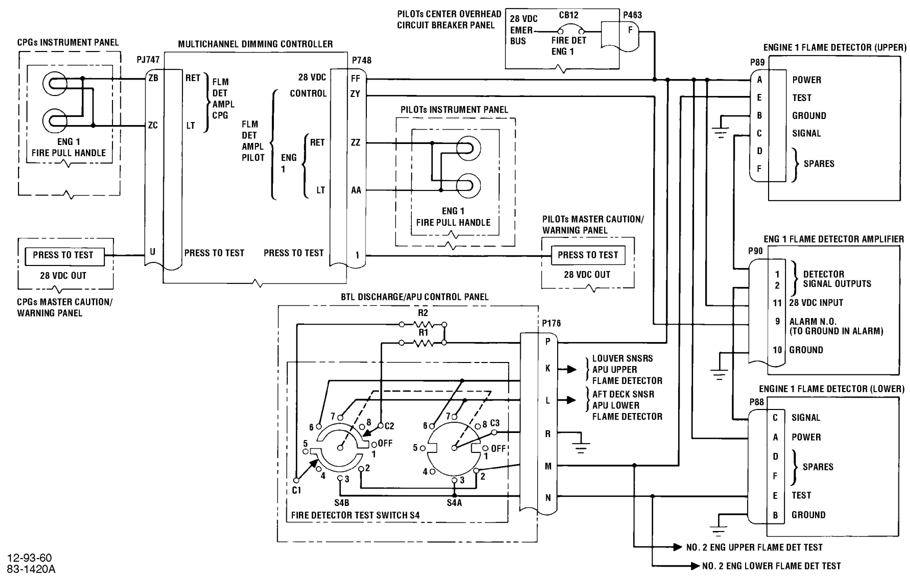
   g. CB13 (FIRE DETR ENG 2) supplies 28 VDC to:

      (1) Engine 2 flame detectors.

      (2) Engine 2 flame detector amplifiers.

      (3) Multichannel dimming controller.

NO. 1 ENGINE FIRE DETECTION SYSTEM SCHEMATIC DIAGRAM



NOTES

F. System operation

1. Fire detection operation

NOTE: Operation of the No. 1 engine fire detection system is identical to the operation of the No. 2 system.

a. CB12 (FIRE DETR ENG 1) supplies 28 VDC to the:

(1) No. 1 engine upper and lower flame detectors.

(2) No. 1 engine flame detector amplifier.

(3) Fire DET test switch.

(4) Multichannel dimming controller.

b. If the upper or lower flame detector senses a flame, a signal is generated and sent to the flame detector amplifier.

(1) The amplifier boosts this signal to trigger a sensitive alarm circuit inside the amplifier.

(2) Once triggered, the alarm circuit provides a ground to actuate the No. 1 engine FIRE PULL handle warning lamp control circuitry of the multi-channel dimming controller.

(3) When actuated, the control circuitry connects 28 VDC and a return path to the pilot and CPG FIRE PULL handle warning lamps. This causes both lamps in the respective FIRE PULL handles to illuminate.

c. Test circuit operation

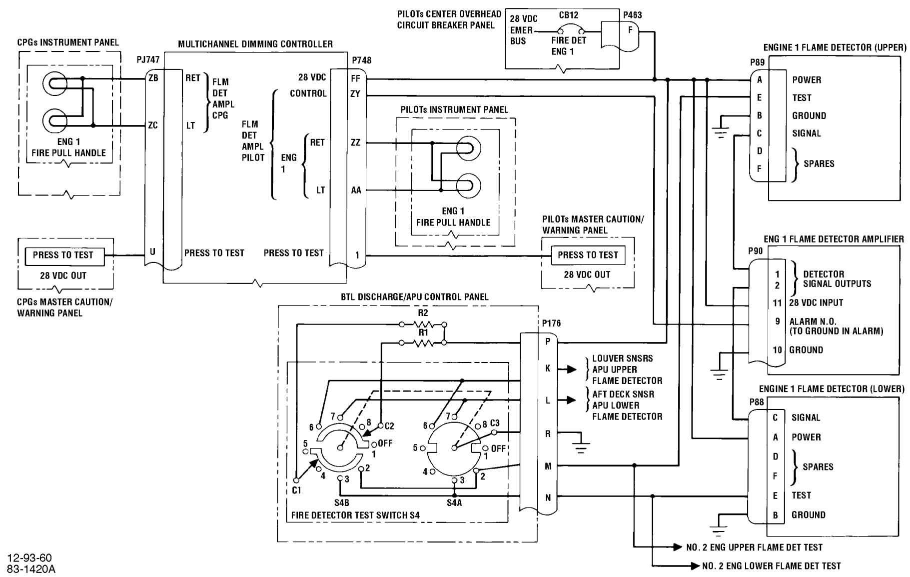
(1) The FIRE PULL handle lamps and the FIRE APU master caution/warning lamps are tested via the master caution/warning panel PRESS TO TEST button in each crewstation.

(2) The caution/warning isolation relay K1-7 (not shown) isolates the pilot's crewstation from the CPG's crewstation during lamp test, and is covered during the caution/warning block of instruction.

(3) CB12 supplies 28 VDC to the FIRE DET test switch.

(a) With the fire test DET switch in the OFF position, a ground is routed from:

NO. 1 ENGINE FIRE DETECTION SYSTEM SCHEMATIC DIAGRAM



NOTES

1) P176R to contacts 2, 3, 6, and 7 of S4A.

2) Contacts 2, 3, 6, and 7 of S4A to the respective TEST inputs of the engine and APU flame detectors.

(b) With a ground at the flame detector TEST inputs, normal system operation is not affected.

(c) When the fire DET test switch is in position 1:

1) Ground is removed from contacts 2 and 6 of S4A and, in turn, the engine and APU upper flame detector TEST inputs.

2) Power is routed from P176P, through R1 and R2, to contacts 2 and 6 of S4B.

3) Contacts 2 and 6 route 28 VDC to the No. 1 and No. 2 engines, respectively, and the APU upper flame detector TEST inputs.

4) The flame detectors are activated and provide a signal to the respective amplifiers, causing all fire warning lights in each crewstation to illuminate.

(d) When the fire DET test switch is in position 2:

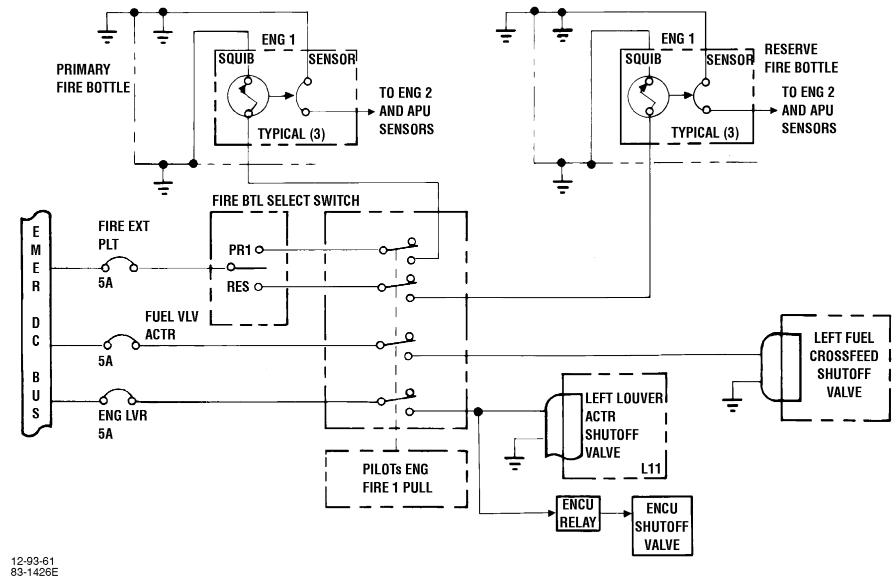
1) Ground is removed from contacts 3 and 7 of S4A and, in turn, the engine and APU lower flame detector TEST inputs.

2) Power is routed from P176P, through R1 and R2, to contacts 3 and 7 of S4B.

3) Contacts 3 and 7 route 28 VDC to the No. 1 and No. 2 engines, respectively, and the APU flame detector TEST inputs.

4) The flame detectors are activated and provide a signal to the respective amplifiers, causing all fire warning lights in each crewstation to illuminate.

FIRE BOTTLE DISCHARGE ENGINE 1 SCHEMATIC



NOTES

NOTE: Operation of the No. 1 and No. 2 engine fire extinguishing systems is identical. Operation of the pilot's fire extinguishing system is identical to the CPG's.

2. Fire extinguishing operation

   a. The No. 1 engine and No. 2 engine fire extinguishing operations are identical and operation of the pilot's system is identical to the CPG's fire extinguishing system.

   b. CB25 (FIRE EXTGH PLT) supplies 28 VDC to the pilot's FIRE BTL select switch.

   c. CB14 (FUEL VLV ACTR) and CB16 (ENG LVR) provide 28 VDC to the pilot's No. 1 and No. 2 ENG FIRE PULL handles.

   d. When the No. 1 ENG FIRE PULL handle is pulled, 28 VDC from CB16 is routed to the left louver actuator shutoff valve and ENCU relay.

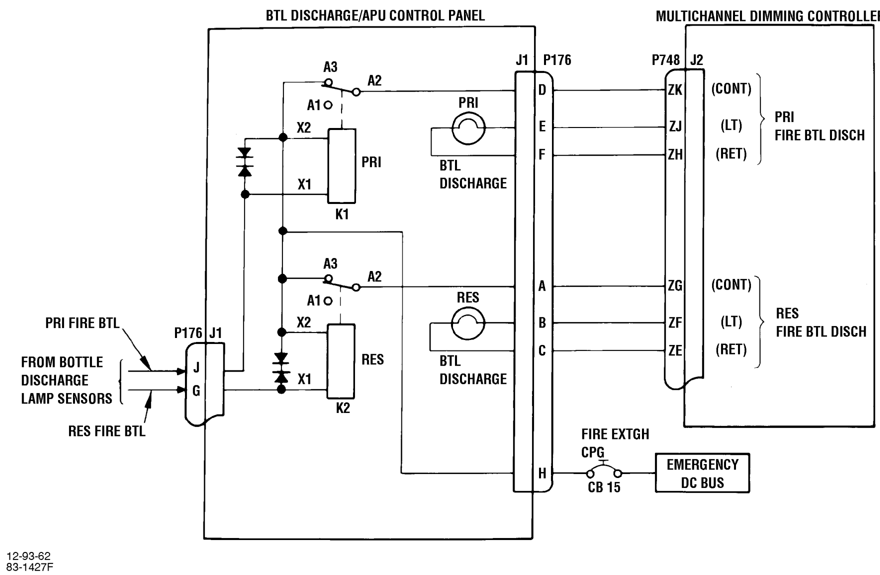
   e. The ENCU relay energizes and removes power from the ENCU shutoff valve. The ENCU shutoff valve is spring-loaded closed. This ensures maximum PAS air for the engine louver system.

   f. The left louver actuator shutoff valve energizes, closes the left engine louver, and limits engine compartment airflow.

   g. 28 VDC from CB14 is also routed to the left fuel cross feed shutoff valve. This actuates the valve, shutting off fuel flow to the No. 1 engine.

   h. When the pilot's FIRE BTL select switch is placed in either the PRI DISCH or RES DISCH position, 28 VDC from CB25 is routed through the FIRE PULL handle to the No. 1 squib of the respective fire bottle. This fires the squib, discharges the bottle contents into the No. 1 engine compartment, and opens the No. 1 engine bottle discharge lamp sensor.

FIRE BOTTLE DISCHARGE LAMPS SCHEMATIC



NOTES

i. When the bottle discharge lamp sensor opens, relay K1 (PRI bottle) or K2 (RES bottle) in the BTL DISCHARGE/APU control panel de-energizes.

j. 28 VDC from CB15 (FIRE EXTGH CPG) is routed through contacts A3 and A2 of relay K1 or K2 to the multichannel dimming controller.

k. The multichannel dimming controller routes 28 VDC to the BTL DISCHARGE/APU control panel to illuminate the respective BTL DISCHARGE lamp.

APU FIRE DETECTION AND EXTINGUISHING SYSTEM MAJOR COMPONENTS

FLAME DETECTORS (2)

FLAME DETECTOR AMPLIFIER

MASTER CAUTION/WARNING PANEL

BTL DISCHARGE/APU CONTROL PANEL

CIRCUIT BREAKERS

FIRE EXTINGUISHING AGENT, TRIPLE VALVE CONTAINER (2)
(FIRE BOTTLE)

15-93-46

NOTES

G. APU fire detection and extinguishing system components

1. Flame detectors (2)

2. Flame detector amplifier

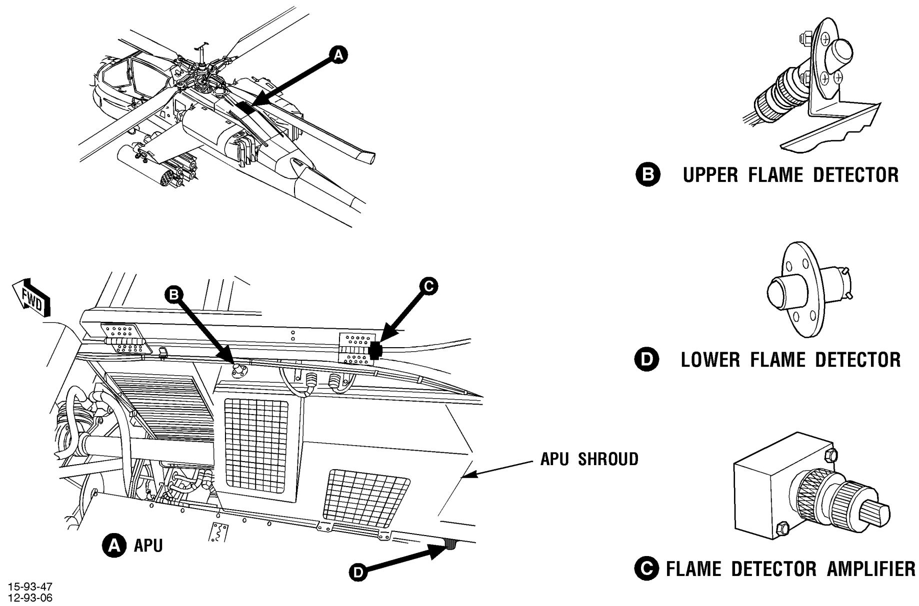
3. Master caution/warning panel

4. BLT discharge/APU control panel

5. Circuit breakers

6. Fire extinguishing agent, triple valve container (2), (fire bottles)

APU FLAME DETECTOR/ AMPLIFIER LOCATION



NOTES

7. APU flame detector/amplifier location

   a. The APU shroud is located in the aft equipment bay.

   b. The upper flame detector is located on the upper forward portion of the APU shroud.

   c. The APU flame detector amplifier is located in the aft equipment bay above the APU shroud.

   d. The lower flame detector is located on the lower aft portion of the APU shroud.

8. Flame detector

   a. Detects flames and provides a signal to the amplifier.

   b. Sealed stainless steel shell with a fish-eye lens housing a solid-state photo-conductive cell.

   c. Optical flame detector capable of detecting the infrared radiation of a flame.

   d. Inspect in accordance with TM 55-1520-238-23-8.

9. Flame detector amplifier

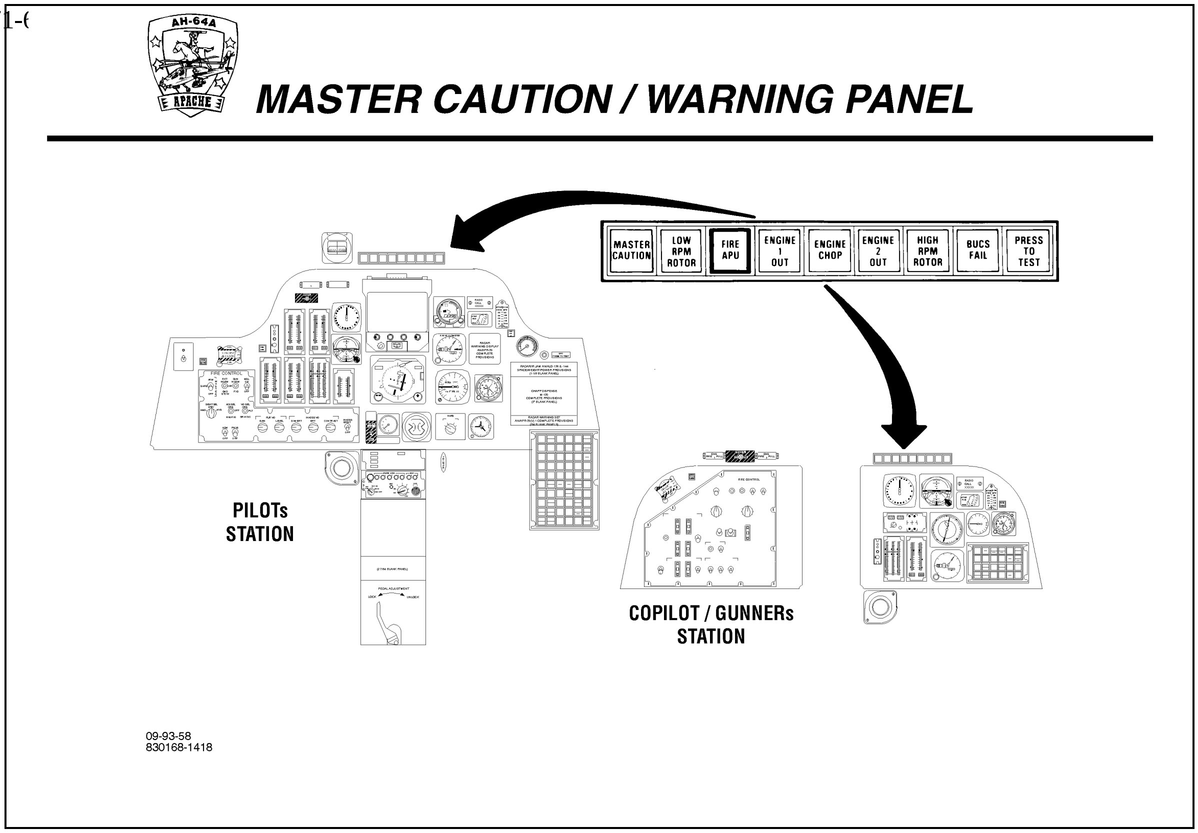
   a. Amplifies electrical input signals from the flame detectors to complete an electrical circuit to the APU fire lights on the pilot and CPG master caution/warning panels.

   b. Completes an electrical circuit to the lights in the fire pull handle located on the BTL discharge/APU control panel.

   c. A closed assembly that houses solid-state electronic components and a relay.

   d. The flame detector transmits an alarm voltage of a magnitude sufficient to activate the APU FIRE PULL handle.

   e. Inspect in accordance with TM 55-1520-238-23-8.


AH-64A
APACHE
MASTER CAUTION / WARNING PANEL
MASTER CAUTION
LOW RPM ROTOR
FIRE APU
ENGINE 1 OUT
ENGINE CHOP
ENGINE 2 OUT
HIGH RPM ROTOR
BUCS FAIL
PRESS TO TEST
PILOTs STATION
COPILOT / GUNNERs STATION
09-93-58
830168-1418

NOTES

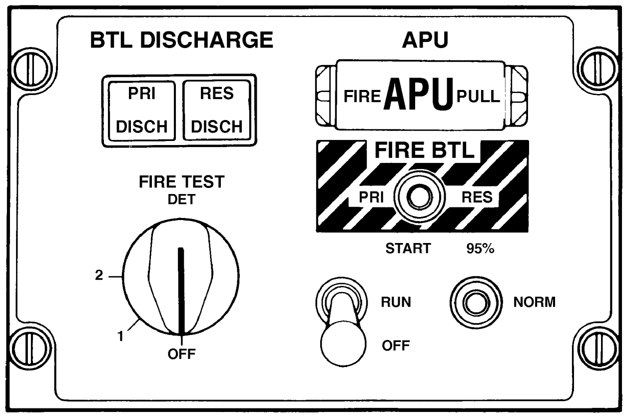
10. Master caution/warning panel

    a. Alerts the pilot and CPG to a fire in the APU compartment.

    b. Located in the pilot crewstation, the master caution/warning panel is located top center of instrument panel. The CPG's master caution/warning panel is located top center of the right side of instrument panel.

    c. Red light segment with black lettering, labeled FIRE APU.

BTL DISCHARGE/APU CONTROL PANEL



12-93-68
83-1417

NOTES

11. BTL discharge/APU control panel

    a. Provides APU fire warning in the FIRE PULL handle.

    b. Provides controls for APU fire extinguishing.

    c. Located on the right side of the pilot's console.

    d. APU FIRE PULL handle

        (1) Alerts the pilot to a fire in the APU compartment.

        (2) T-type handles with two (2) red lenses covering two (2) peanut type bulbs, one on each end of the T.

12. Fire bottle select switch

    a. Three-position switch that is mounted to a plate painted with black and yellow diagonal stripes

    b. Spring-loaded to the center position (neutral).

    c. Left position, labeled PRI, allows crew to fire selected squib on primary bottle manifold.

    d. Right position, labeled RES, allows crew to fire selected squib on reserve bottle manifold.

13. FIRE TEST DET switch

    a. Allows the pilot or maintenance personnel to perform an operational test (continuity check) of the engine and APU fire detector circuitry and components.

    b. Located on the BTL DISCHARGE/APU control panel on the pilot right console.

    c. A four-position, momentary, spring-return to OFF, rotary switch.

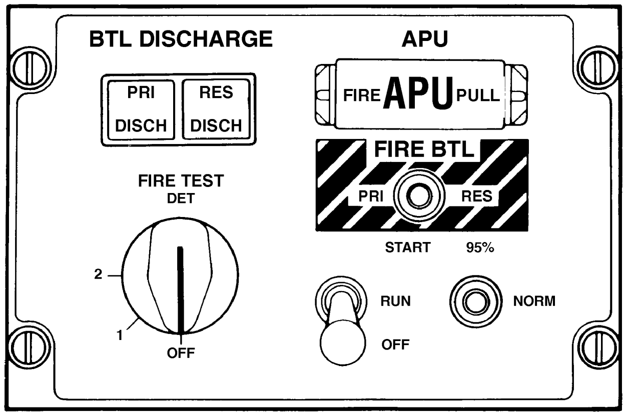
    d. First position is labeled OFF.

    e. Second position is labeled 1 and tests the upper detector circuits and components. If the systems are intact and functioning properly, the ENG 1 and ENG 2 FIRE PULL handles and APU FIRE master caution/warning lights in each crewstation illuminate. The APU FIRE PULL handle in the pilot crewstation also illuminates.

    f. Third position is labeled 2 and tests the lower detector circuits and each system amplifier. If the systems are intact and functioning properly, the same warning lights illuminated in position 1 illuminate again.

    g. Fourth position is not used.

BTL DISCHARGE/APU CONTROL PANEL



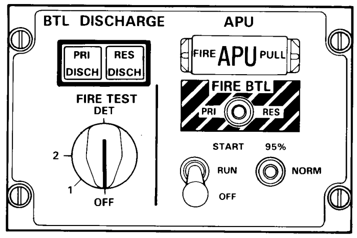
12-93-68
83-1417

NOTES

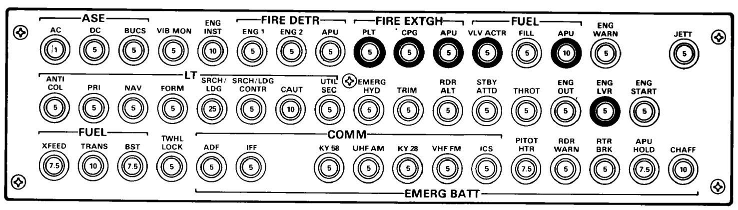
14. Fire bottle discharge advisory lamps

    a. Advise the pilot that a fire bottle has been discharged. The two (2) lamp assemblies (PRI DISCH and RES DISCH) illuminate green when the respective fire bottle has been discharged.

FIRE EXTINGUISHING SYSTEM ADVISORY LAMPS AND CIRCUIT BREAKERS



BTL DISCHARGE/APU
CONTROL PANEL



12-93-58
86-91

PILOTs CENTER OVERHEAD CB PANEL

NOTES

15. Fire extinguishing systems circuit breakers

    a. Provide excessive current protection.

    b. Located on pilot's center overhead circuit breaker panel.

    c. FIRE EXTGH PLT, CPG, and APU Circuit Breakers (CB25, CB15, and CB26)

        (1) Rated at 28 VDC and 5 amperes.

        (2) Powered by the emergency DC Bus.

        (3) CB25 supplies 28 VDC to the pilot's engine FIRE BTL select switch.

        (4) CB15 supplies 28 VDC to the CPG engine FIRE BTL select switch and BTL DISCHARGE lamp relays A138 K1 and K2.

        (5) CB26 supplies 24/28 VDC to the APU FIRE BTL select switch.

16. Associated subsystem circuit breakers

    a. FUEL APU (CB9) and FUEL VLV ACTR (CB14)

        (1) Rated at 28 VDC, 10 amperes and 5 amperes, respectively.

        (2) Powered by the emergency DC Bus.

        (3) CB9 supplies 28 VDC for the APU fuel shutoff valve.

        (4) CB14 supplies 28 VDC for the left and right fuel cross feed shutoff valves.

    b. ENG LVR (CB16)

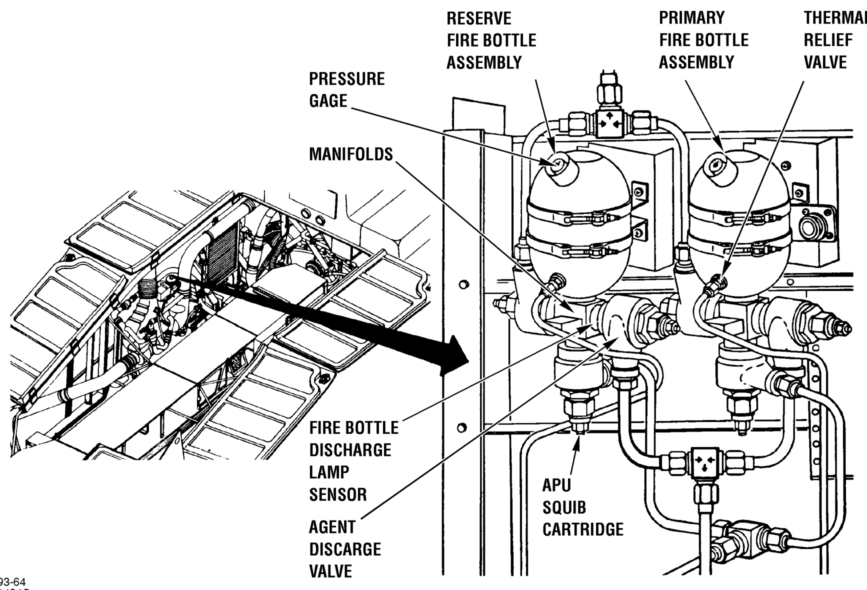
        (1) Rated at 28 VDC and 5 amperes.

        (2) Powered by the emergency DC Bus.

        (3) Supplies 28 VDC for the left and right engine louver actuator shutoff valves.

    c. Inspection criteria covered previously.

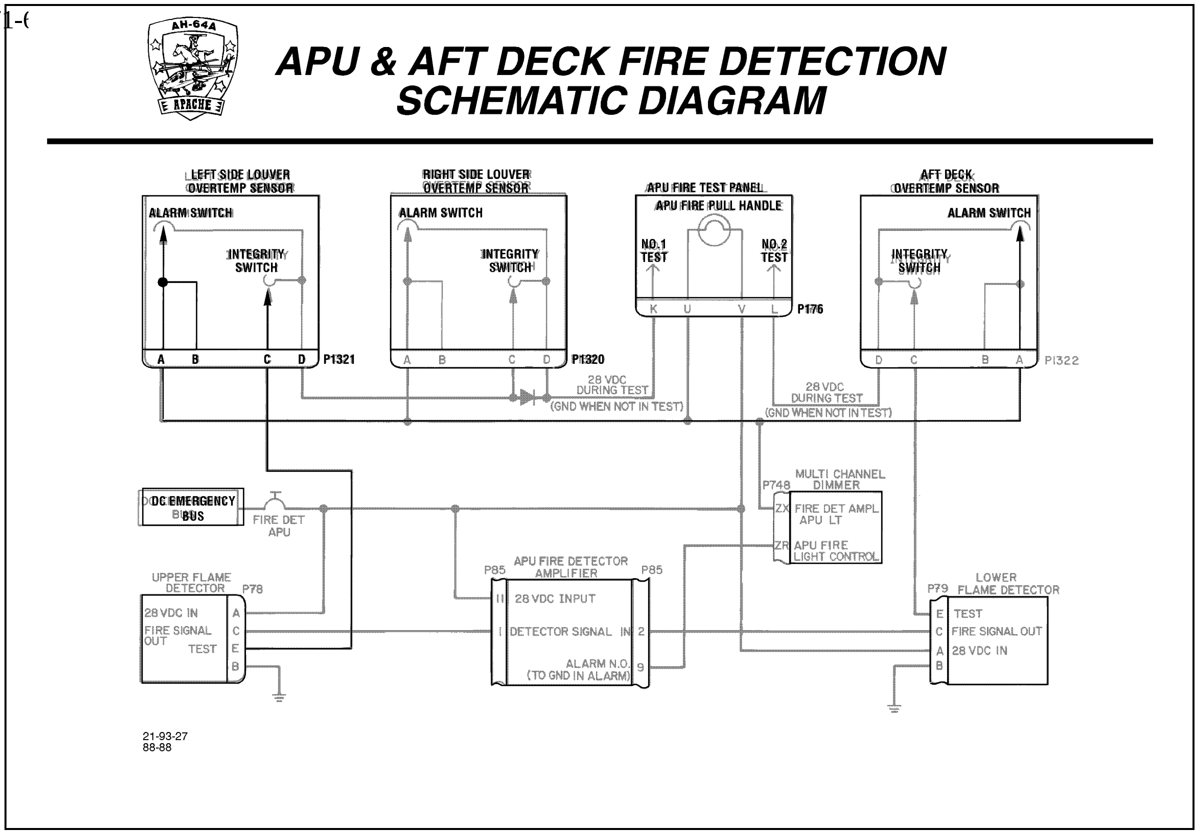
FIRE BOTTLE ASSEMBLIES



12-93-64
83-1424C

NOTES

17. Fire bottle assemblies for the APU are the same assemblies as those used for the engines.


AH-64A
APACHE
APU & AFT DECK FIRE DETECTION
SCHEMATIC DIAGRAM
LEFT SIDE LOUVER OVERTEMP SENSOR
ALARM SWITCH
INTEGRITY SWITCH
P1321
RIGHT SIDE LOUVER OVERTEMP SENSOR
P1320
APU FIRE TEST PANEL
APU FIRE PULL HANDLE
NO.1 TEST
NO.2 TEST
P176
AFT DECK OVERTEMP SENSOR
PI322
28 VDC DURING TEST
(GND WHEN NOT IN TEST)
MULTI CHANNEL DIMMER
P748
FIRE DET AMPL APU LT
APU FIRE LIGHT CONTROL
DC EMERGENCY BUS
FIRE DET APU
UPPER FLAME DETECTOR
P78
28 VDC IN
FIRE SIGNAL OUT
TEST
APU FIRE DETECTOR AMPLIFIER
P85
28 VDC INPUT
DETECTOR SIGNAL IN
ALARM N.O. (TO GND IN ALARM)
LOWER FLAME DETECTOR
P79
TEST
FIRE SIGNAL OUT
28 VDC IN
21-93-27
88-88

NOTES

18. Fire detection operation

    a. 28 VDC power is applied to the APU flame detectors and APU flame detector amplifier from the emergency DC Bus.

    b. APU flame detectors pick up infrared and ultraviolet radiation emitted by flames in the APU compartment.

        (1) Infrared - outside the visible spectrum at the red end, longer wavelengths than visible light.

        (2) Ultraviolet - outside the visible spectrum at the violet end. Shorter wavelength than visible light and shorter than those of x-ray.

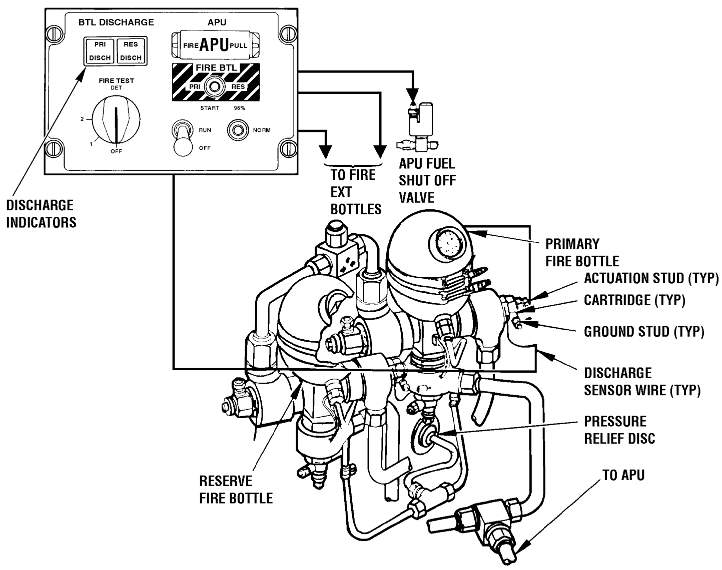
    c. The radiation produces a small voltage in the detector. The voltage is picked up by the amplifier.

    d. A flashlight with a red filter directed on the lens will activate the fire detection system with power applied to the aircraft.

    e. The amplifier increases the voltage and routes it to the multichannel dimming controller.

    f. Multichannel dimming controller provides a control signal to light the APU FIRE PULL handle and APU FIRE light in the master caution/warning panels.

APU FIRE EXTINGUISHER OPERATION



15-93-07
83-2071

NOTES

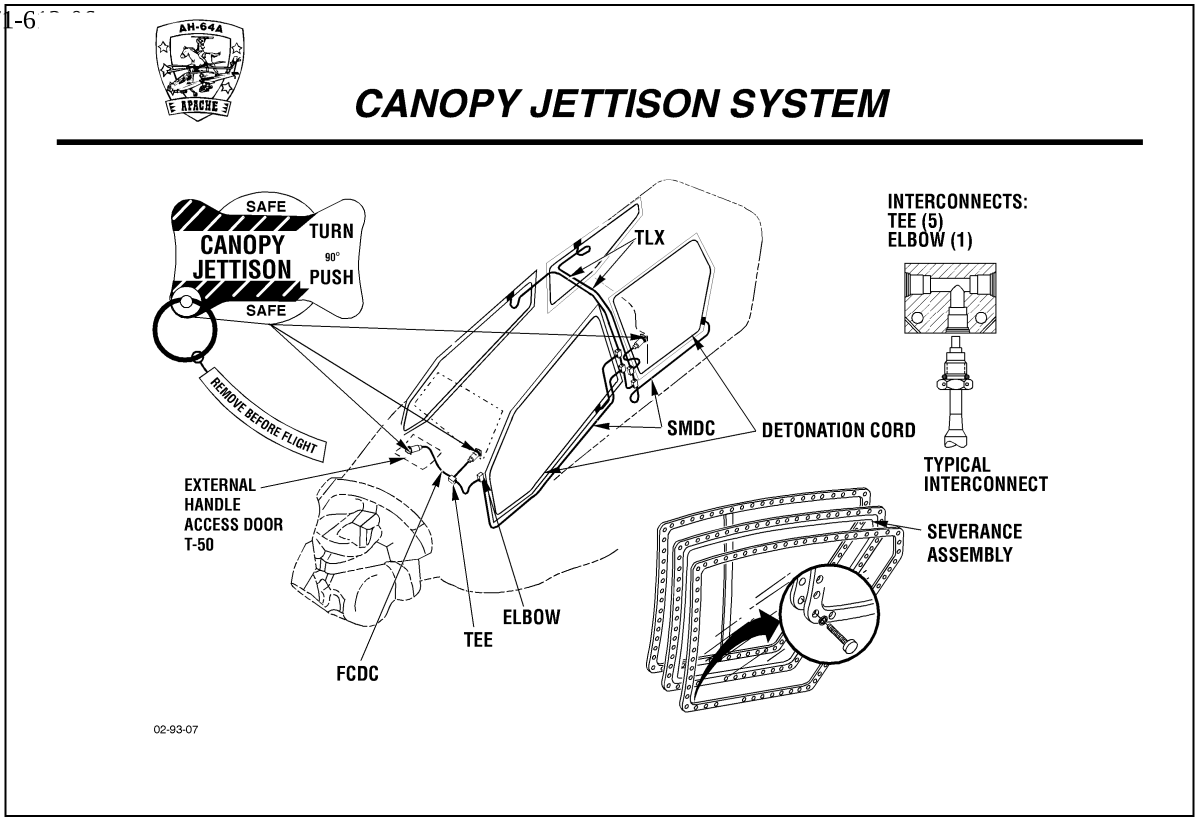
19. Fire extinguishing system

    a. When the APU FIRE PULL handle is pulled, it closes the APU fuel shutoff valve.

    b. It also completes a circuit between the selected squib on the fire bottle manifold and the FIRE BTL PRI/RES select switch.

    c. When the select switch is moved to PRI position, 28 VDC is applied to the selected squib on the primary fire bottle, firing the squib and releasing the extinguishing agent.

    d. The extinguishing agent is routed to the APU through aluminum alloy plumbing.


AH-64A
APACHE
CANOPY JETTISON SYSTEM
SAFE
CANOPY
JETTISON
TURN
90°
PUSH
SAFE
REMOVE BEFORE FLIGHT
TLX
INTERCONNECTS:
TEE (5)
ELBOW (1)
SMDC
DETONATION CORD
TYPICAL
INTERCONNECT
EXTERNAL
HANDLE
ACCESS DOOR
T-50
SEVERANCE
ASSEMBLY
ELBOW
TEE
FCDC
02-93-07

NOTES

WARNING

Detonation cords and initiators are explosive. Do not move canopy initiator handles or remove safety pins in pilot or CPG stations. Detonation may cause severe personal injury. If injury occurs, seek medical aid.

WARNING

Canopy jettison safety pins shall be installed in pilot, CPG, and external firing mechanisms when the helicopter is on the ground. The canopy jettison system is manually operated. The canopy can be jettisoned when no electrical power is on the helicopter. Pilot and CPG safety pins shall be removed before starting engines, otherwise the safety pins will be installed at all times when the aircraft is on the ground. Safety pins shall be installed during engine shutdown check.

WARNING

Debris may be expelled 50 feet (15.25 meters) outward when system is actuated. Pilot and CPG helmet visor should be down to prevent eye injury.

A. Canopy jettison system

1. A pyro-technically operated canopy jettison system.

   a. Provides rapid egress paths when the helicopter is downed and one or both access doors are jammed or blocked.

   b. Instantly severs the four (4) acrylic side panels.

2. System components

   a. Three (3) CANOPY JETTISON handles

      (1) Provide initiation of canopy jettison system.

      (2) One each located on the upper left side of the pilot and CPG instrument panels.

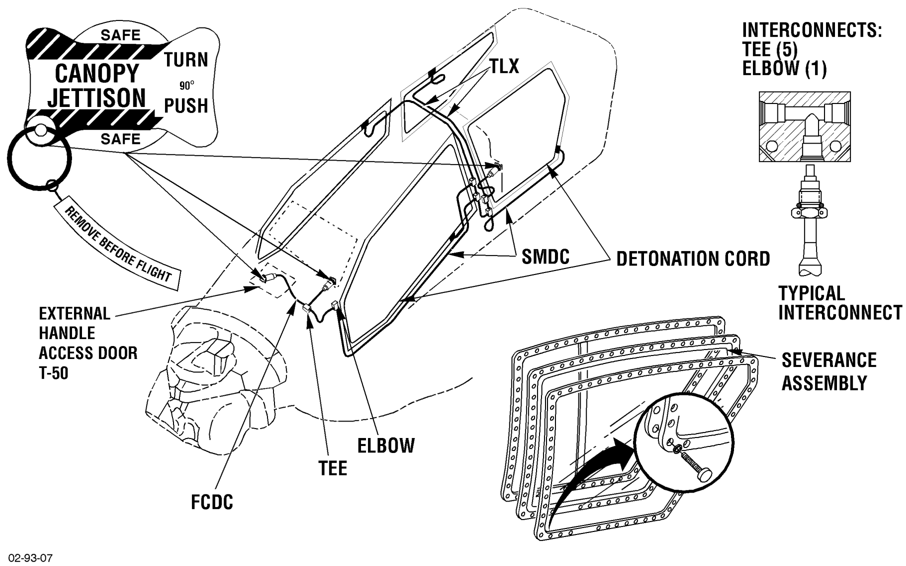
      (3) One located under access door T-50 (external handle).

   b. Detonation is transmitted via the shielded mild detonation cord (SMDC), flexible confined detonating cord (FCDC), and thin line explosive cord (TLX) to the four (4) acrylic side panels.

   c. Detonation cord (X-cord) is installed around the periphery of each of the four (4) acrylic side panels.

   d. Five (5) interconnect tees provide system interface.

CANOPY JETTISON SYSTEM



NOTES

e. A single interconnect elbow connects the external handle and the CPG's handle to an interconnect tee.

f. Four (4) severance assemblies are installed between the canopy panel frame and window panel which contain the X-Cord.

3. System operation

a. The system is self-contained and requires no external sources of power for operation.

b. To safe the system normally, a quick-release safety pin is used to hold the CANOPY JETTISON handles in the SAFE position.

c. Safety pins are removed before flight.

d. After flight, each handle is safed with the quick-release pin. Verification of a safed or armed position is indicated by the word ARMED (uncovered by handle) to either side of the handle, or SAFE at top and bottom of canopy jettison.

e. To arm the system, any one (1) of the three (3) CANOPY JETTISON handles is rotated 90E left or right.

WARNING

M Activation of the canopy removal system when combustible fuel/vapors are present in the cockpit can result in an explosion/fire. An explosion/fire can also occur if the aircraft has rolled on its side and fuel/vapors have gathered on the ground adjacent to the canopy side panels. The crew-member's survival knife may be used to fracture the canopy side panels as an alternate means of egress.

M Rotate the canopy jettison handle to the ARM (90°) position and release. Push the handle to actuate the canopy jettison. Continuing to twist the canopy jettison handle while trying to push may cause the actuator piston to jam and thereby prevent operation of the canopy severance system. If canopy jettison does not occur on the first attempt, insure the handle is in the 90° position, and push again. A push force of 140 - 150 pounds may be required to overcome the jam and initiate canopy jettison.

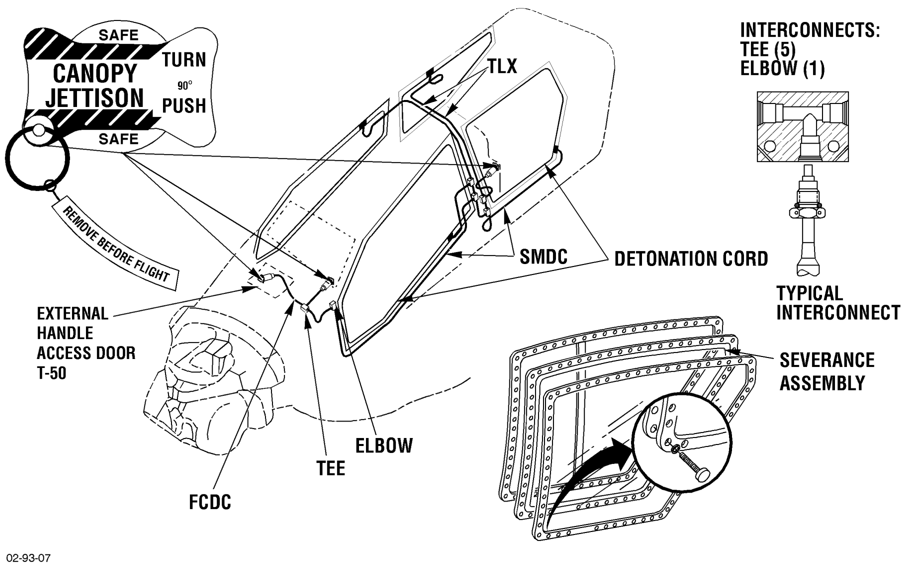
M In the event that canopy jettison does not occur when the canopy removal system is actuated, the personal survival knife should be used to fracture the canopy panel and permit egress.

f. To activate the system, the rotated CANOPY JETTISON handle is pushed in. This detonates a cartridge similar to a 0.38 caliber bullet. (The handle consists of a spring-loaded firing pin striking a primer/initiator subassembly.)

g. The cartridge ignites the FCDC which burns to the SMDC, TLX, and detonation cord.

h. The FCDC, SMDC, and TLX (detonation/burn wave) travels at 6,800 meters (22,304 feet) per second.

CANOPY JETTISON SYSTEM



NOTES

i. The detonation cord ignites and burns around the periphery of the canopy side panels. The burning action cuts a fine line, severing the four acrylic panels from the canopy frame.

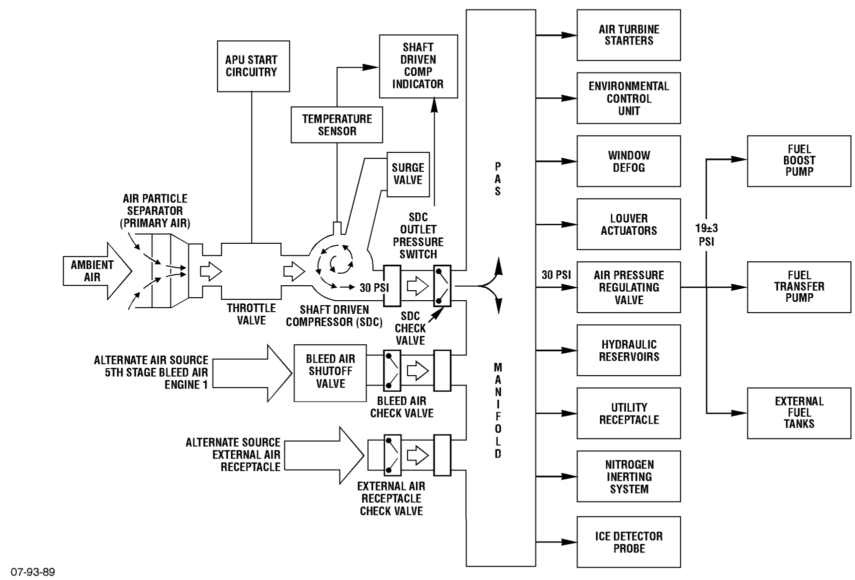
j. Entire (detonation/burn) time of the CANOPY JETTISON system detonating cartridge and detonation cords, from the time detonating cartridge has ignited to the time all detonation cords have burned around the periphery of the pilot and CPG canopy, is 150 to 300 Micro-seconds (microsecond is unit of time equal to one-millionth of a second).

4. The canopy jettison system is covered in TM 55-1520-238-8, volume 8, chapter 12.

WARNING

Do not attempt to move jettison handles when performing inspections. System may detonate. Detonation may cause severe personal injury.

PAS BLOCK DIAGRAM



NOTES

WARNING

To prevent injury to personnel, do not perform any maintenance on pressurized air system until pressure is removed from helicopter.

A. Pressurized air system (PAS)

1. The PAS cleans, pressurizes, regulates, and distributes air to pneumatically operated systems and components of the AH-64A.

2. All PAS components are located in the aft equipment bay, with the exception of the external air and utility receptacles which are located in the bottom of No. 1 engine nacelle.

3. Input sources and interfacing

a. Input sources

(1) The primary source is the shaft driven compressor (SDC).

(2) The secondary source is the No. 1 engine bleed air, if the primary source fails.

(3) The external source is an auxiliary ground power unit (AGPU).

b. Interfacing - the PAS system distributes pressurized air to the following systems/components.

(1) Engine air turbine starters (ATS)

(2) Environmental control unit

(3) Window defog

(4) Louver actuators

(5) Air pressure regulating valve

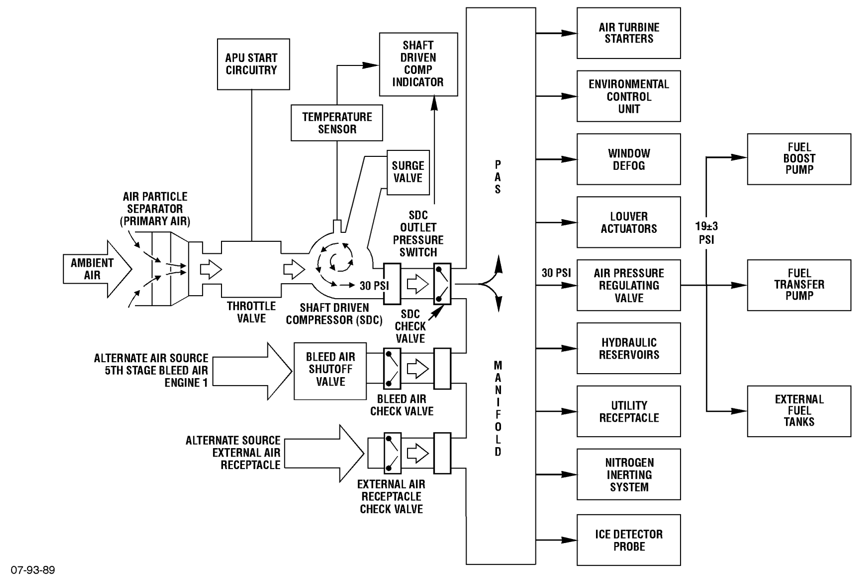
(a) Fuel boost pump

(b) Fuel transfer pump

(c) External fuel tanks

(6) Blade deice sensor

PAS BLOCK DIAGRAM



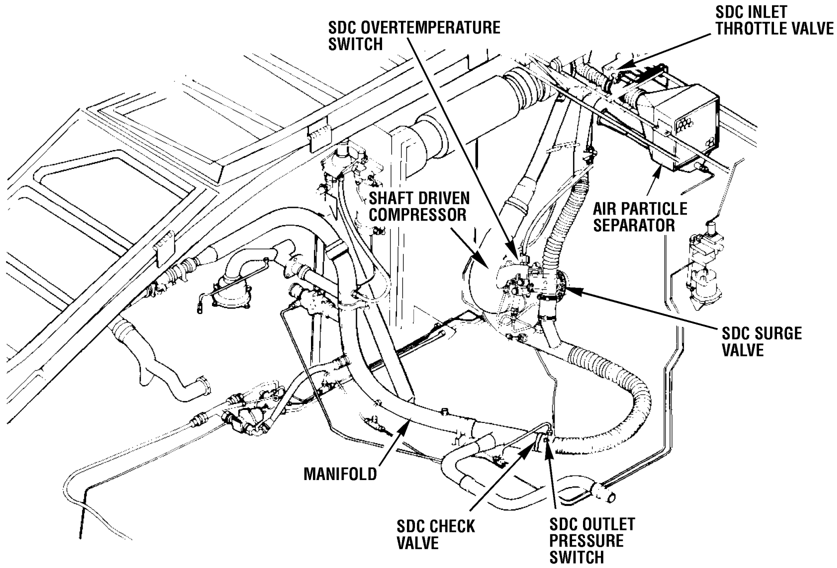
NOTES

(7) Hydraulic system

(8) Utility receptacle

(9) Nitrogen inerting system

PRESSURIZED AIR SYSTEM COMPONENTS



NOTES

4. Major components

    a. Air particle separator

    b. SDC inlet throttle valve

    c. SDC over-temperature switch

    d. SDC and surge valve

    e. SDC outlet pressure switch and check valve

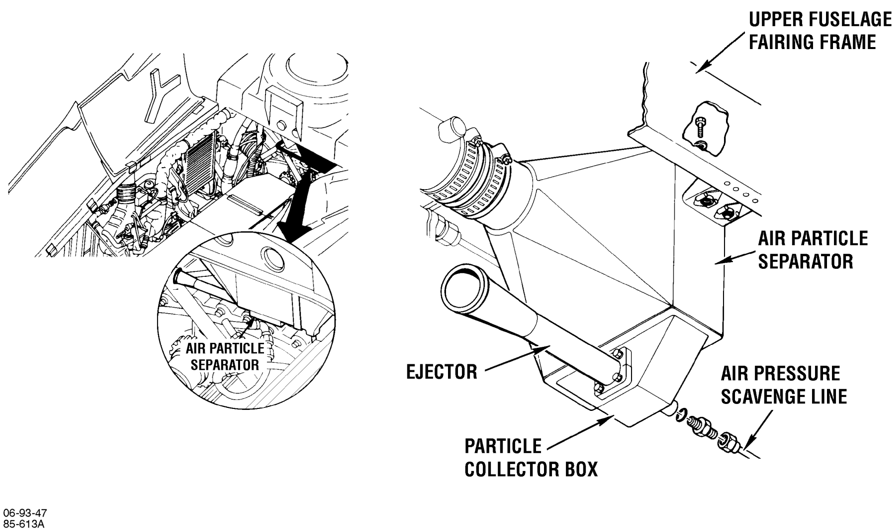
    f. Manifold

B. Component description

1. Air particle separator

    a. Cleans the air by removing 85% of the particles 20 microns or larger, before it enters the SDC. [A micron (or micrometer) is a unit of length equal to one-millionth of a meter (.000001).]

AIR PARTICLE SEPARATOR LOCATION



NOTES

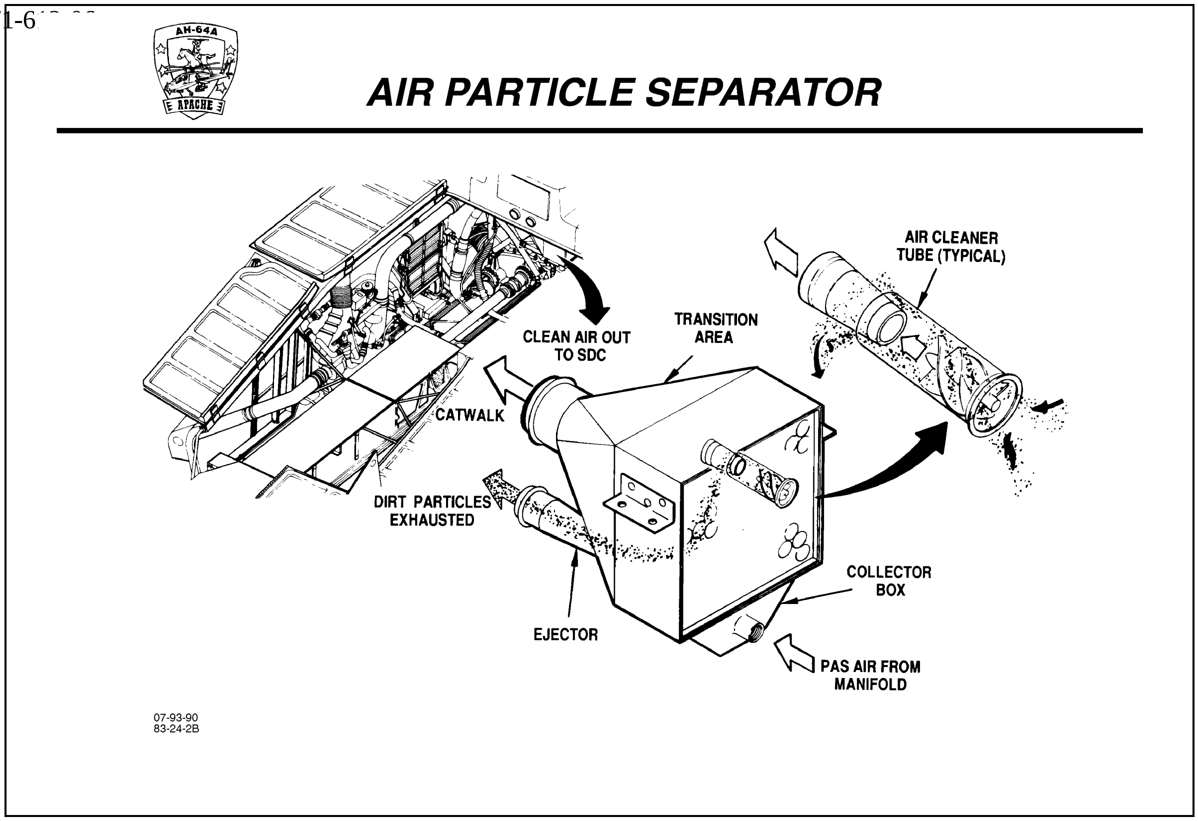
b. Mounted to the upper fuselage fairing frame. The frame is located at the forward portion of the aft equipment bay, upper right side.

c. Made of welded aluminum with internal parts that do not move and cannot be removed.

d. An integral particle collector box is located at the lower portion of the separator.

e. An air pressure scavenge line is attached to the outboard section of the particle collector box. The other end of the scavenge line is attached to the PAS manifold.

f. An ejector tube is attached to the inboard side of the particle collector box.


AH-64A
APACHE
AIR PARTICLE SEPARATOR
AIR CLEANER
TUBE (TYPICAL)
TRANSITION
AREA
CLEAN AIR OUT
TO SDC
CATWALK
DIRT PARTICLES
EXHAUSTED
COLLECTOR
BOX
EJECTOR
PAS AIR FROM
MANIFOLD
07-93-90
83-24-2B

NOTES

g. Operation

(1) Air filtering is accomplished by centrifugal air flow through 72 cleaner tubes.

(2) Outside air is drawn into the air particle separator through an air inlet assembly, at the right main rotor shaft fairing (T205R).

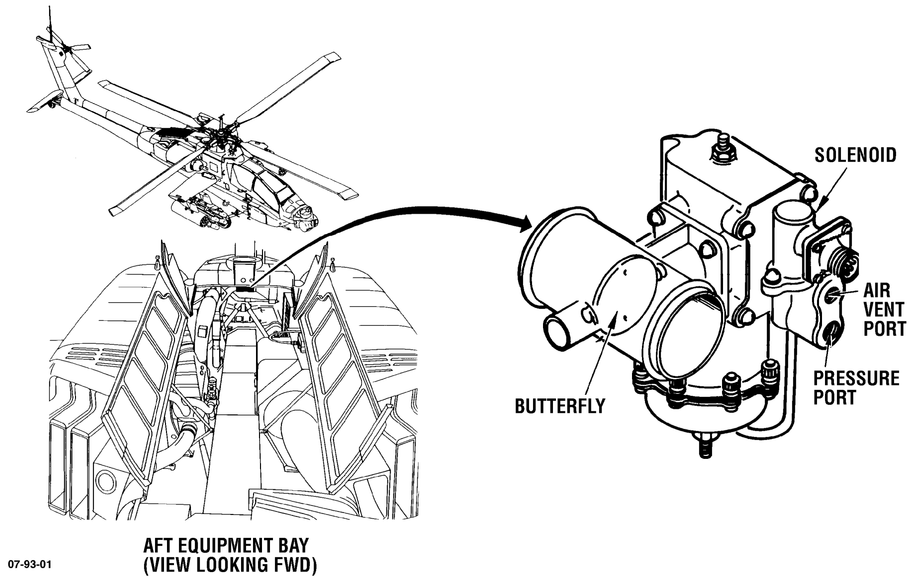
(3) Air cleaner tubes with swirl vanes cause the air to swirl outward, separating the dirt particles and throwing them to the sides of the tube.

(4) The clean air passes through the center of a conically shaped tube, to the transition area, then on to the rest of the PAS. The dirt particles travel out around the conically shaped tube to the collector box.

(5) The PAS scavenge line, directs air into the collector box and out the ejector. This creates a low-pressure area and a jet-pump action that pulls the dirt particles out of the collector box and forces them through the ejector tube.

(6) Air filtering and dirt particle removal are accomplished any time the SDC is in operation.

SDC INLET THROTTLE VALVE



NOTES

2. Inlet throttle valve

   a. Reduces the starting load on the APU by decreasing the amount of air available to the SDC by approximately 70%.

   b. Located at the forward end of the aft equipment bay (catwalk area), left of the air particle separator. Mounted to a bracket on the upper fuselage frame.

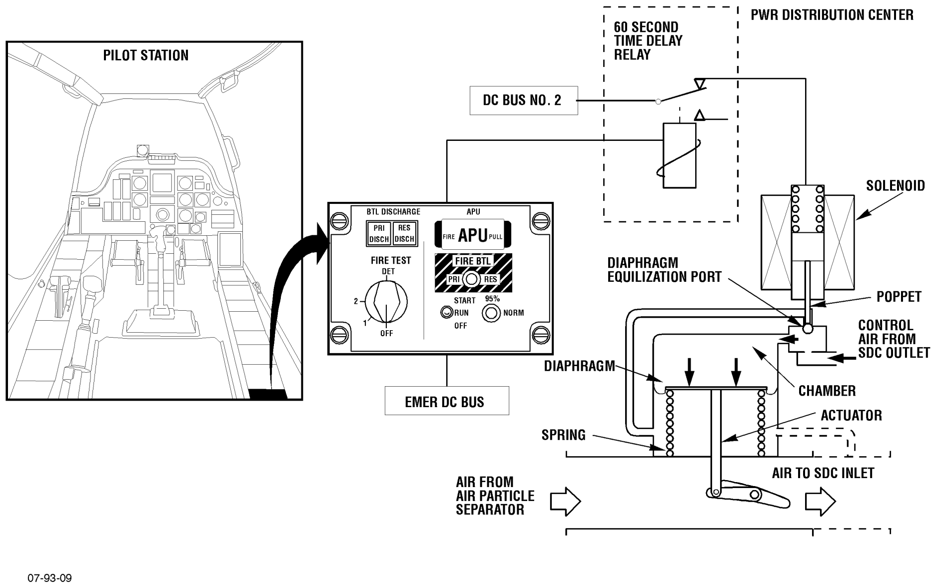
   c. Consists of a valve body, a solenoid, a butterfly valve, and air tubing.

      (1) The butterfly valve is spring loaded to the closed position, solenoid controlled, and pneumatically operated. Air pressure overrides the butterfly valve spring and causes it to open.

      (2) The solenoid is controlled by the APU START/RUN switch through a 60-second time delay relay. The solenoid opens or closes an air pressure and air vent port with a poppet valve.

      (3) The air pressure and air vent port control air pressure within the inlet throttle valve for operation.

SDC INLET THROTTLE VALVE OPERATION



NOTES

d. Operational description

(1) 28 VDC from essential bus 2 is routed through CB57 (FUEL BST) and continuously applied to the inlet throttle valve solenoid.

(2) The solenoid poppet valve opens the air pressure port and closes the vent port. Pressurized air from the SDC enters the inlet throttle valve's chamber. The pressurized air in the chamber overrides spring tension and opens the inlet throttle valve (permitting air flow to the SDC).

(3) The inlet throttle valve remains open as long as 28 VDC is applied to its solenoid and a minimum of 15 psi PAS air is available at the pressure port.

(4) When 28 VDC is removed from the inlet throttle valve's solenoid, the solenoid's poppet valve closes the air pressure port and opens the vent port. The pressurized air within the chamber vents allowing spring tension to close the inlet throttle valve.

NOTE: For the following scenarios, it must be remembered that the purpose of the inlet throttle valve is to off-load the SDC during APU starts.

e. Inlet throttle valve operation during APU start: engines are not operating, external power is not applied

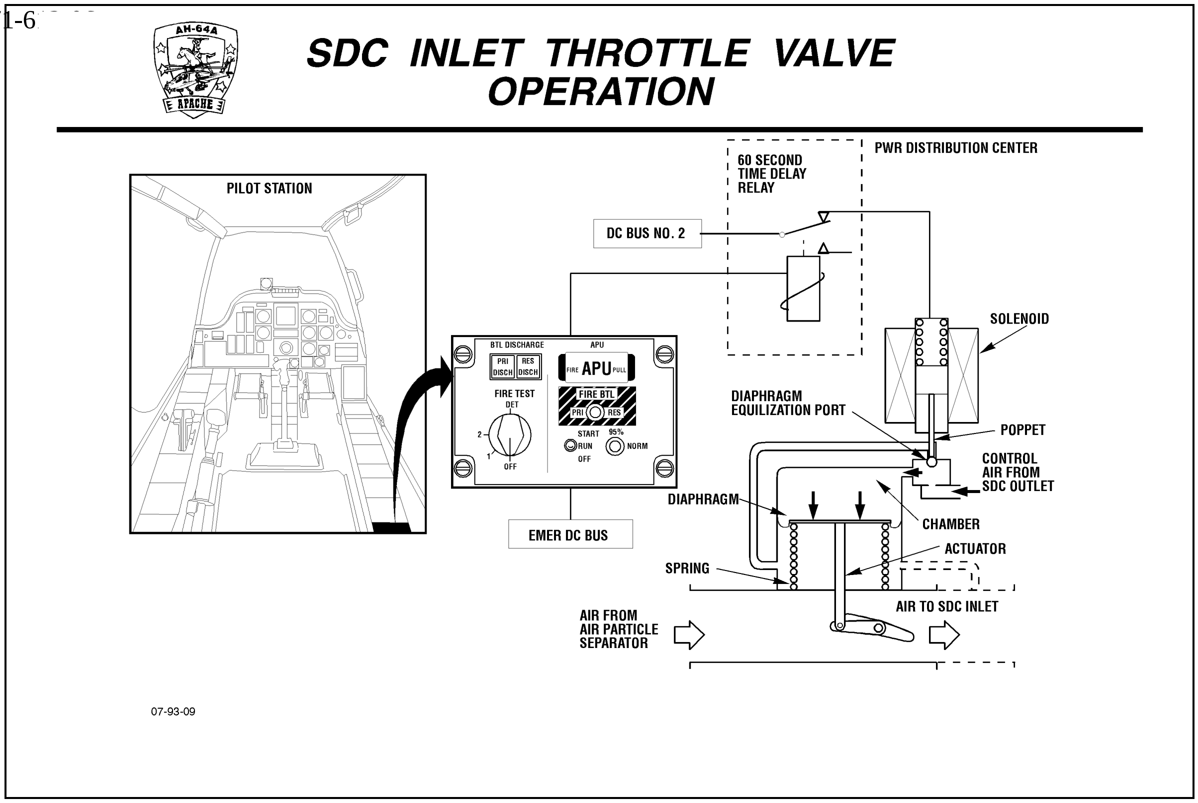
(1) When starting the APU without the engines operating or external power applied to the aircraft, essential DC bus No. 2 is not powered, therefore power is not applied to the inlet throttle valve solenoid.

(2) Since power is not applied to the inlet throttle valve solenoid, the solenoid poppet valve keeps the pressure port closed and the vent port open. This allows spring tension to hold the inlet throttle valve in the closed position.

(3) Placing the APU START/RUN switch to START will not energize a 60-second time delay relay. (The 60 second time delay is not needed because the inlet throttle valve is already closed, consequently off-loading the APU during start).

(4) After the APU is started and the pilot "powers-up" essential DC bus No. 2 by turning the generators on, the inlet throttle valve solenoid receives power.

(5) The solenoid poppet valve opens the air pressure port and closes the vent port. Pressurized air from the SDC enters the inlet throttle valve's chamber. The pressurized air in the chamber overrides spring tension and opens the inlet throttle valve (permitting air flow to the SDC).


AH-64A
APACHE
SDC INLET THROTTLE VALVE
OPERATION
PILOT STATION
60 SECOND
TIME DELAY
RELAY
PWR DISTRIBUTION CENTER
DC BUS NO. 2
BTL DISCHARGE
PRI DISCH
RES DISCH
APU
FIRE APU PULL
FIRE TEST
DET
2
1
OFF
FIRE BTL
PRI
RES
START
95%
RUN
NORM
OFF
EMER DC BUS
SOLENOID
DIAPHRAGM
EQUILIZATION PORT
POPPET
CONTROL
AIR FROM
SDC OUTLET
DIAPHRAGM
CHAMBER
ACTUATOR
SPRING
AIR FROM
AIR PARTICLE
SEPARATOR
AIR TO SDC INLET
07-93-09

NOTES

f. Inlet throttle valve operation during APU start: engines are operating (rotor at 100%), external power is not applied.

(1) When starting the APU with the engines operating and rotor rpm at 100%, the essential DC bus No. 2 is powered (as long as at least one generator is on-line). Therefore, power is applied to the inlet throttle valve solenoid.

(2) Since power is applied to the inlet throttle valve solenoid, the solenoid poppet valve keeps the pressure port open and the vent port closed. This allows pressurized air from the SDC to override spring tension and hold the inlet throttle valve in the open position.

(3) Placing the APU START/RUN switch to START will energize a 60-second time delay relay.

(4) The 60 second time delay removes power from the inlet throttle valve solenoid. This positions the solenoid poppet valve so that the pressure port is closed and the vent port is open. This allows spring tension to hold the inlet throttle valve in the closed position, consequently off-loading the SDC.

(5) After 60 seconds has elapsed, power is applied to the inlet throttle valve solenoid and the inlet throttle valve opens.

(6) When starting the APU with the engines operating and rotor rpm at 100%, the 60 second time delay is not needed (even though it happens) because the engines are driving the SDC through the main transmission. The APU is off-loaded during the entire start because the PTO clutch does not engage until the rotor rpm drops below 94% - 96% rpm.

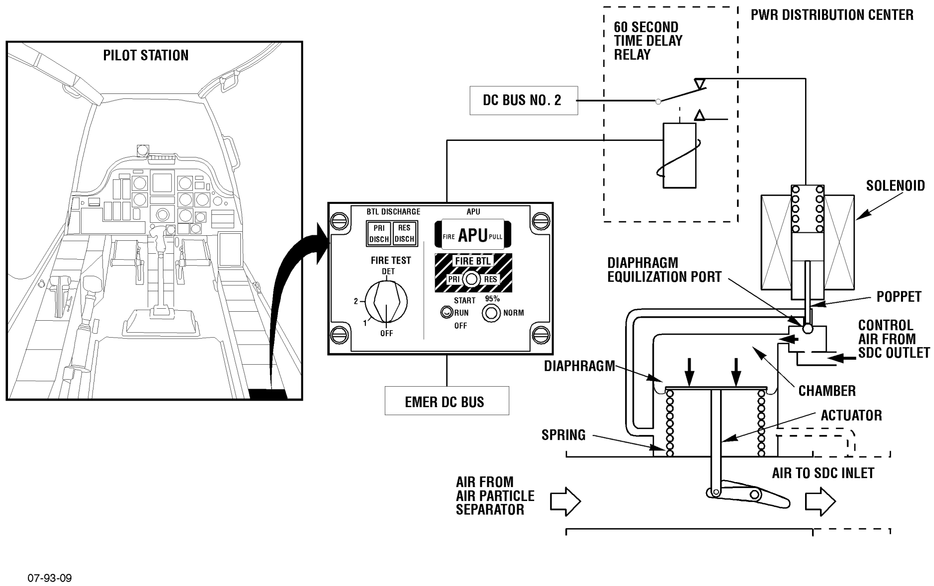
g. Inlet throttle valve operation during APU start: engines are not operating, external power is applied.

(1) When starting the APU with external power applied to the aircraft, essential DC bus No. 2 is powered. Therefore, power is applied to the inlet throttle valve solenoid.

(2) Since power is applied to the inlet throttle valve solenoid, the solenoid poppet valve keeps the pressure port open and the vent port closed. This allows pressurized air from the SDC to override spring tension and hold the inlet throttle valve in the open position.

(3) Placing the APU START/RUN switch to START will energize a 60-second time delay relay.

SDC INLET THROTTLE VALVE OPERATION



NOTES

(4) The 60 second time delay removes power from the inlet throttle valve solenoid. This positions the solenoid poppet valve so that the pressure port is closed and the vent port is open. This allows spring tension to hold the inlet throttle valve in the closed position, consequently off-loading the SDC.

(5) After 60 seconds has elapsed, power is applied to the inlet throttle valve solenoid and the inlet throttle valve opens.

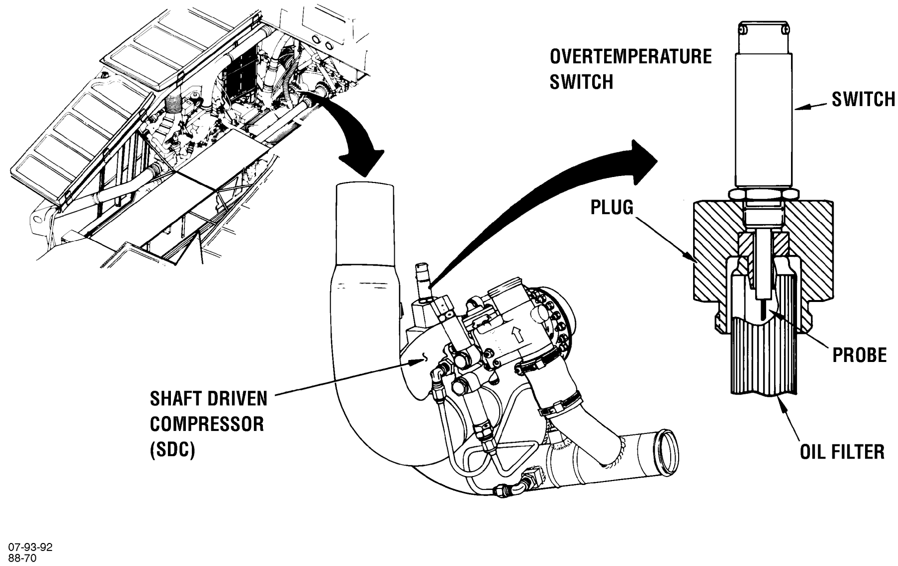
(6) When starting the APU with external power applied, the 60 second time delay is needed. If during a start, the APU was permitted to drive a fully loaded SDC, the APU controller could cause the APU to automatically shut-down.

h. Inlet throttle valve operation during APU start: general.

(1) Any time the APU START/RUN switch is placed to the START position and essential DC bus No. 2 is powered, the inlet throttle valve closes for 60 seconds.

(2) The only situation in which the 60 second time delay is needed to off-load the SDC is during an APU start with external power applied to the aircraft (rotor not turning).

SDC OVERTEMPERATURE SWITCH



NOTES

3. Over-temperature switch

   a. Provides early warning indication of SDC overheating that could lead to SDC failure.

   b. Attached to the oil filter element access plug assembly.

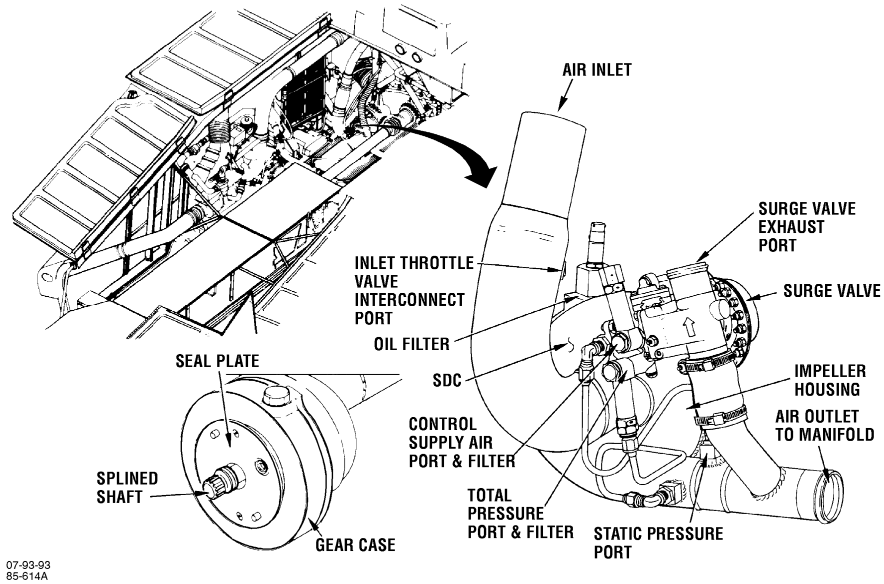
   c. Hermetically sealed LRU.

   d. A probe at the end of the switch is immersed in, and monitors the temperature of, the return oil inside the filter cavity.

      (1) The switch is a normally opened 28 VDC switch that closes when a temperature of 340EF to 360EF (171EC to 182EC) is sensed. When the switch closes, it illuminates the SHAFT DRIVEN COMP caution light on the pilot's C/W/A panel.

      (2) The switch is wired in parallel with the SDC pressure switch.

SDC AND SURGE VALVE



NOTES

4. SDC and surge valve

CAUTION

Ensure surge valve pressure hose is not kinked or twisted after installation. Failure to do so could cause SDC malfunction.

CAUTION

To prevent damage to shaft driven compressor, bleed air shutoff valve/check valve must be installed with hinge vertical and arrow pointing toward pressure manifold.

CAUTION

Removal of surge valve is for access purposes only. SDC and surge valve are a mated pair. Reinstall same surge valve only. Failure to do so could result in damage to SDC.

CAUTION

To prevent damage to tail rotor drive shaft and hydraulic lines, use caution while removing compressor.

a. The SDC draws ambient air through the air particle separator, compresses it, and routes it to the PAS manifold.

b. The surge valve maintains a constant pressure in the PAS system and eliminates surges.

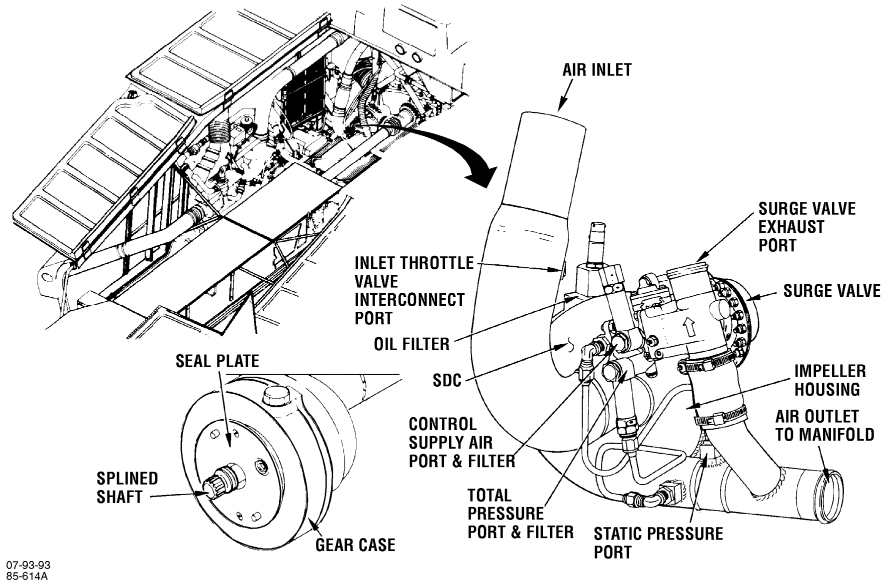
c. SDC and surge valve are mounted as a unit on the left rear face of the main transmission accessory section via a V-band clamp.

d. The SDC is a single-stage centrifugal compressor with an aluminum housing. It is a sealed unit except for a replaceable oil filter.

e. Produces clean pressurized air at 30 psi (207 kPa) heated to 375EF " 50EF (190EC "10EC).

(1) An inlet throttle valve interconnect port is located on the air inlet portion of the SDC. The vent air from the throttle valve is directed to this port.

SDC AND SURGE VALVE



NOTES

(2) A static pressure port and total pressure port exist at the air outlet portion of the SDC. These ports are connected to the surge valve for operation.

(3) A filter element attached to the total pressure port and the supply port on the surge valve removes any contaminants (from the air) that could cause damage to the surge valve.

(4) If the filter becomes clogged, the surge valve goes into a bypass mode causing the surge valve to dump excessive amounts of air overboard. The symptoms that would be prevalent under this condition are:

(a) No air or low air into cockpits during normal APU operations.

(b) Engines will have a very low engine gas generator speed (N_G) during start sequence or will not start at all. (With low N_G, the possibility of starters hanging is present.)

(c) Greater amount of air "dumping" overboard than normal during APU operation.

f. SDC components

(1) SDC major components

(a) Gear case

(b) Impeller housing

(c) Splined shaft

(2) Splined shaft - designed to shear under excessive loads to prevent damage to the transmission.

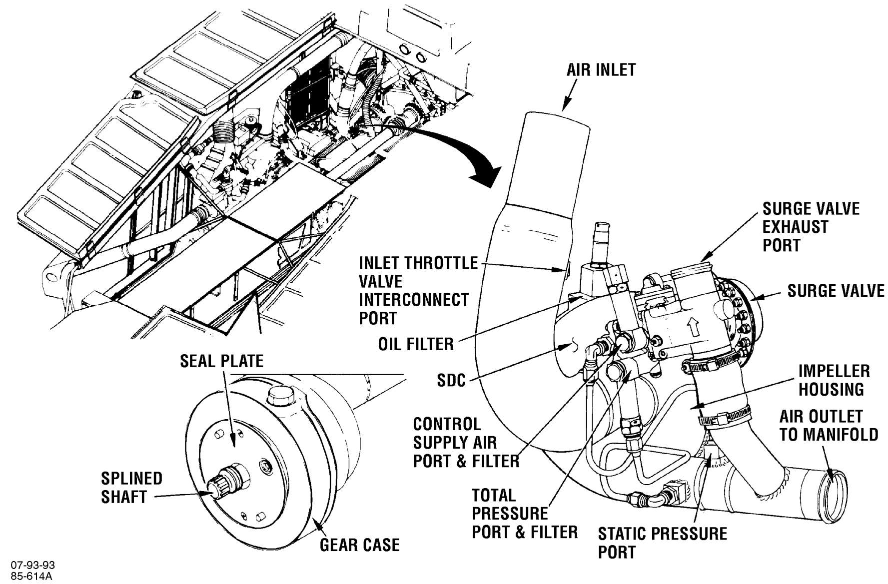
(3) Seal plate - (replaceable) contains two ports which house molded rubber seals.

(4) Ports - allow the passage of oil from and back to the transmission accessory section (SDC lubrication).

(5) Gear case - attached to the SDC via two flush-mounted screws and contains two indexing pins to facilitate installation.

(6) Flush-mounted screws - are not a common type of screw. They are high-torque screws and require a special tool for removal.

SDC AND SURGE VALVE



NOTES

(7) Rubber seals - under compression, the molded rubber seals allow metal-to-metal contact and provide a sealing effect between the SDC and transmission.

(8) Oil filter - (cleanable) is corrosion-resistant steel wire mesh element, rated at 40 microns nominal and 70 microns absolute.

g. Surge valve

(1) Pneumatically actuated, modulating butterfly-type valve, spring-loaded open (un-pressurized).

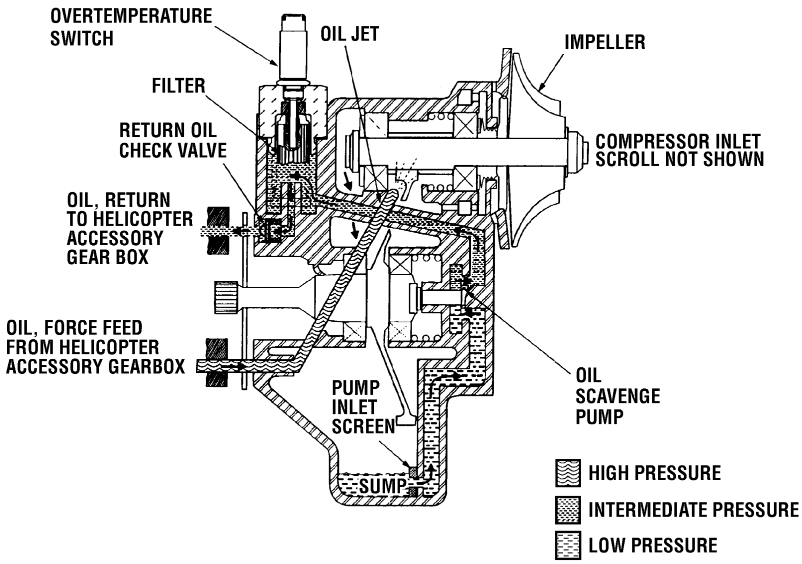
(2) A control supply air port provides interface with the PAS manifold. The surge valve utilizes the supply air, static pressure, and total pressure to operate.

(3) Modulated by differential pressure. When the valve senses that air pressure and flow are not correct, it opens or closes as necessary to maintain the correct pressure/flow from the compressor.

(4) Designed to open rapidly to eliminate pressure surges that could cause compressor stall.

(5) The exhaust port discharges the excessive compressor air flow through an interconnect tube to the exhaust exit located on T250R.

SDC OPERATION



07-93-06

NOTES

h. SDC operation

(1) Automatic with APU on or either engine driving the main rotor.

(2) The main transmission gear train drives the splined shaft which rotates the spur gear at 12,251 rpm. The spur gear drives the impeller at 86,431 rpm.

(3) The impeller compresses the inlet air and sends it to the PAS system.

(4) The surge valve modulates and regulates the air pressure and flow prior to sending it to the manifold.

(5) The SDC utilizes the main transmission accessory section oil to provide lubrication to the bearings and gear meshes.

(a) High-pressure oil is forced from the accessory section of the transmission to the SDC and into an oil jet (tri-jet). The oil jet directs oil spray to the two ball bearings that support the impeller shaft and the diverging gear mesh.

(b) Oil is then gravity-fed (drip) through internal passages to lube the main shaft ball bearings before returning to a sump.

(c) Low-pressure oil is drawn from the sump through the pump inlet screen by an oil scavenge pump, which is driven by the main gear shaft.

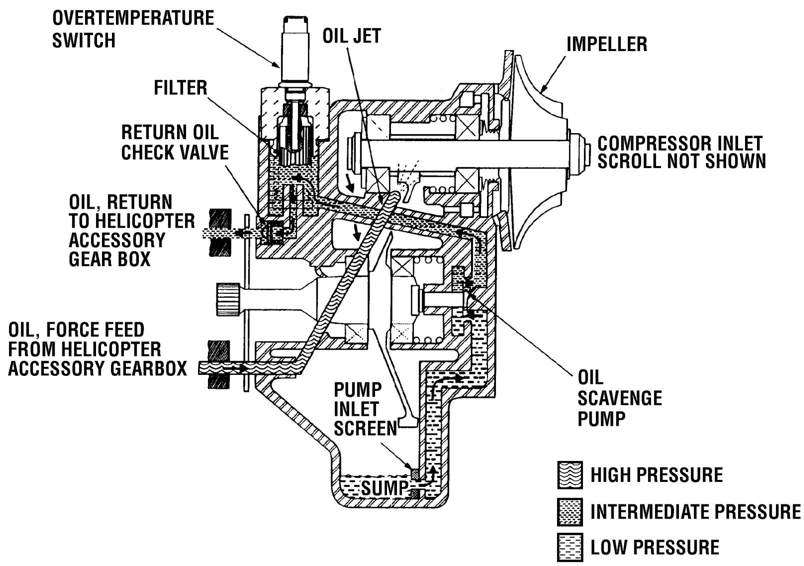
(d) The addition of the inlet screen is incorporated with the -17 SDC. Its purpose is to reduce the possibility of jamming the scavenge pump with debris (or contamination) caused by an internal failure that does not shear the drive shaft.

(e) Intermediate-pressure oil from the scavenge pump is sent to the oil return filter element. Contaminants are removed prior to directing the oil back to the transmission accessory section.

(f) Once filtered, the intermediate-pressure oil returning to the transmission accessory section is monitored for an impending over-temperature condition by the over-temperature switch.

(g) A one way check valve allows the filtered oil to be returned from the SDC to the accessory gearbox while preventing reverse flow of the same oil from the accessory gearbox return port to the SDC.

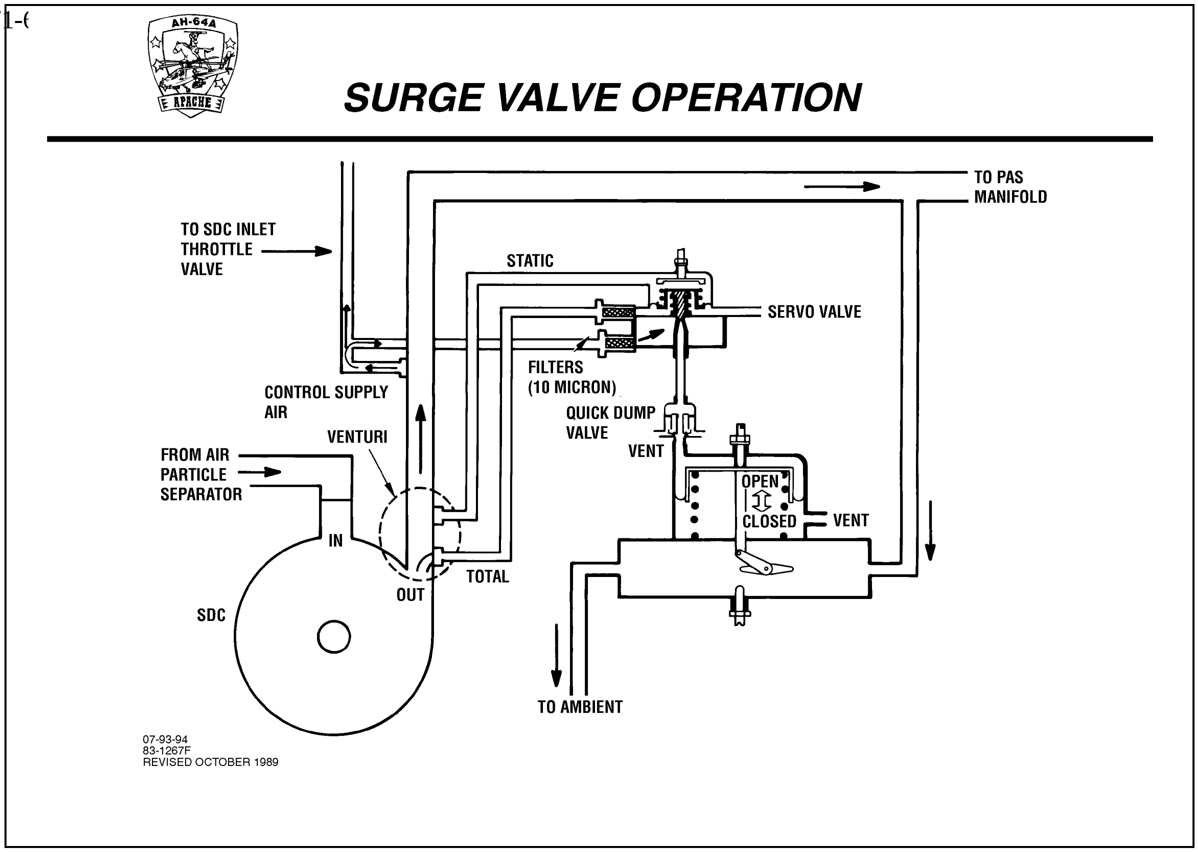
SDC OPERATION



07-93-06

NOTES

(h) The housing and scroll are designed to contain the fragments in the unlikely event of a compressor impeller failure.


AH-64A
APACHE
SURGE VALVE OPERATION
TO PAS
MANIFOLD
TO SDC INLET
THROTTLE
VALVE
STATIC
SERVO VALVE
FILTERS
(10 MICRON)
CONTROL SUPPLY
AIR
QUICK DUMP
VALVE
VENTURI
VENT
FROM AIR
PARTICLE
SEPARATOR
OPEN
CLOSED
VENT
IN
TOTAL
OUT
SDC
TO AMBIENT
07-93-94
83-1267F
REVISED OCTOBER 1989

NOTES

i. Surge valve operation

(1) Normal

(a) The servo valve is lightly spring-loaded to the closed position.

(b) The upper side of the servo valve diaphragm senses static, or a slightly reduced, pressure from the SDC outlet airflow.

(c) The lower side senses total pressure or SDC output.

(d) The SDC outlet total-to-static pressure differential acts upon the control servo diaphragm, which modulates the supply pressure to the valve actuator diaphragm to position the butterfly valve at the proper operating condition.

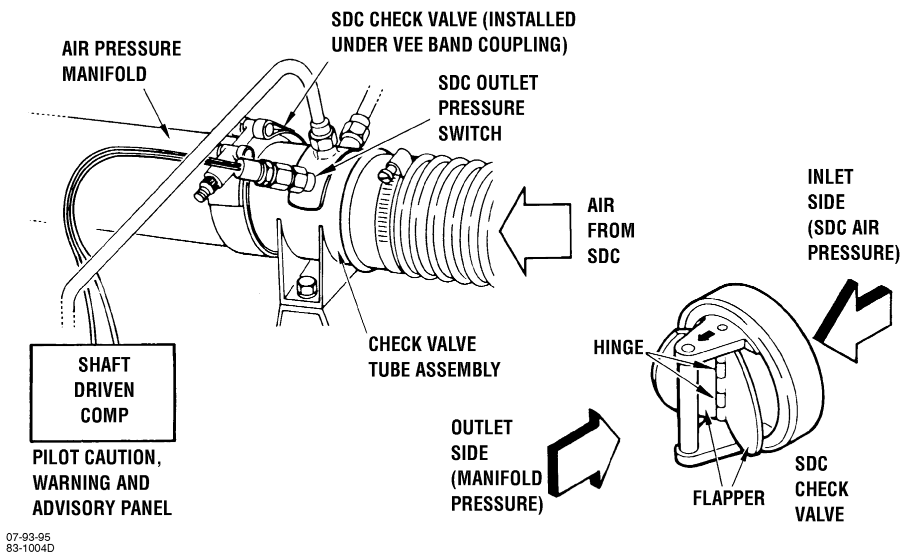
(2) Dump

(a) The quick dump valve vents the surge valve actuator pressure when the servo valve suddenly closes.

(b) When the servo valve closes, the back flow of actuator pressure to the vents opens the quick dump valve.

(c) This allows the spring pressure against the diaphragm to open the butterfly, dumping a portion of the SDC output overboard to prevent surges which could result in compressor stall.

SDC OUTLET PRESSURE SWITCH AND CHECK VALVE OPERATION



NOTES

5. SDC outlet pressure switch and check valve

   a. SDC Outlet Pressure Switch monitors SDC outlet pressure and controls the SHAFT DRIVEN COMP caution light on the pilot's C/W/A panel.

   b. SDC outlet check valve prevents loss of air (back flow) through the SDC when secondary or external air is being supplied.

   c. Both components are mounted to the check valve tube assembly located between the flexible SDC outlet hose and the air pressure manifold (aft equipment bay deck).

   d. SDC outlet pressure switch

      (1) Aluminum alloy body, hermetically sealed switch.

      (2) Two amps maximum load at 28 VDC.

      (3) With no air pressure in the manifold, the switch is closed and the pilot's C/W/A panel light segment labeled SHAFT DRIVEN COMP is illuminated.

      (4) When air pressure increases to 15 psi (103 kPa), the switch opens, extinguishing the SHAFT DRIVEN COMP light segment.

      (5) In the event of an SDC failure, the decreasing pressure in the manifold causes the switch to close at 7 psi (48.3 kPa). This causes the C/W/A light to illuminate.

   e. SDC outlet check valve

      (1) Dual flapper valve, pneumatically operated, which allows air flow in one direction.

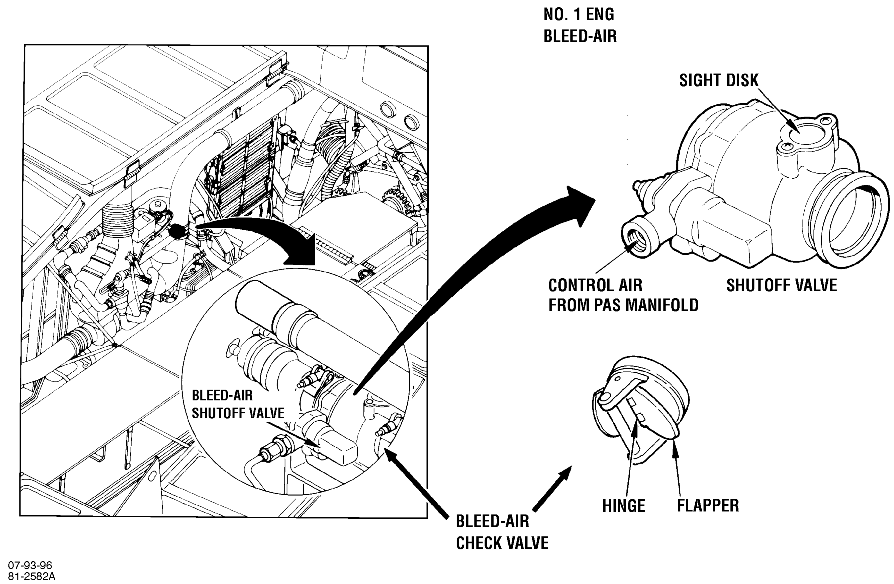
      (2) Contains an arrow to facilitate proper installation. The arrow indicates proper air flow.

      (3) There is a possibility of improper installation of the SDC check valve. The valve can be installed with flapper hinge pin 90E out of alignment, which puts the pivot pin in a horizontal position allowing the upper flapper door fall open.

      (4) During normal operation, the SDC outlet pressure is greater than manifold pressure. The SDC check valve opens and SDC air pressure flows into the manifold.

      (5) With the No. 1 engine supplying pressurized air to the manifold (in the event of SDC failure) or the usage of an external air source, the check valve prevents the escape of the air through the SDC.

BLEED-AIR SHUTOFF VALVE AND CHECK VALVE



NOTES

C. PAS secondary air source

1. Fifth stage bleed air from the No. 1 engine is the secondary air source.

2. Secondary air source components are the bleed air shutoff valve and check valve.

a. Bleed air check valve

(1) Prevents manifold air from entering the bleed air shutoff valve when the primary or external air is operating.

(2) Installed into the PAS manifold at the connection point for the bleed air shutoff valve.

(3) Dual flapper valve, pneumatically operated, which allows airflow in one direction.

(4) Operates in the same manner as the SDC outlet check valve, but is not interchangeable due to the different diameters. The SDC outlet check valve is approximately 2 inches (5.08 cm) in diameter, and the bleed air check valve is approximately 1.50 inches (3.81 cm).

b. Bleed air shutoff valve

(1) Prevents the flow of the fifth-stage bleed air into the PAS manifold during normal SDC operation.

(2) Fifth-stage bleed air from the No. 1 engine is rated at 8-18 psi (55.2 - 124.2 kPa) with the No. 1 engine operating at 100% flat pitch, at sea level. However, bleed air pressure varies depending on engine power setting and altitude.

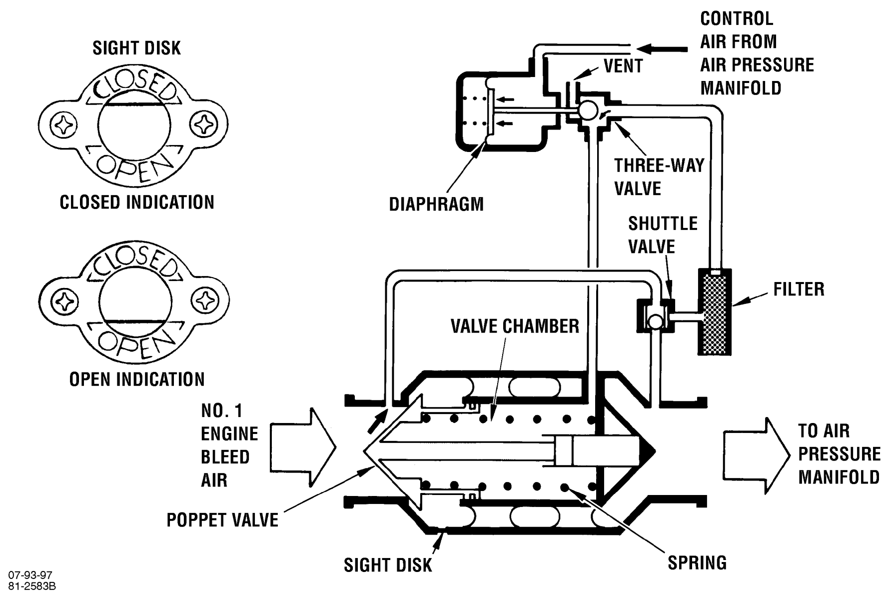
(3) Automatically allows flow of No. 1 engine bleed air to the manifold when the SDC outlet pressure drops below 14 psi (96.5 kPa), decreasing.

(4) Located left side of the aft equipment bay, mounted between the No. 1 engine bleed air input and the PAS manifold.

(5) Spring-loaded closed, in-line poppet type, pneumatically controlled and pneumatically actuated.

(6) Enclosed in an aluminum alloy body with a valve position indicator, sight disk, and a port for control air from the PAS manifold.

BLEED AIR SHUTOFF VALVE OPERATION



NOTES

3. Bleed air shut off valve operation

   a. Control air from the PAS manifold acts on the spring-loaded diaphragm to unseat the poppet which closes the vent port of the three-way valve.

   b. Engine bleed air enters the shutoff valve inlet and passes through the internal passages to the shuttle valve, filter, and three-way valve and into the valve chamber.

   c. The combination of spring force and bleed air pressure inside the poppet valve chamber holds the poppet valve closed.

   d. If PAS manifold air drops to 14 psi (96.5 kPa) at the diaphragm, the poppet in the three-way valve begins to open the vent and close the inlet (vent is full open at 10 psi [68.9 kPa]).

   e. Engine bleed air is now restricted from entering the valve chamber and air in the valve chamber vents overboard.

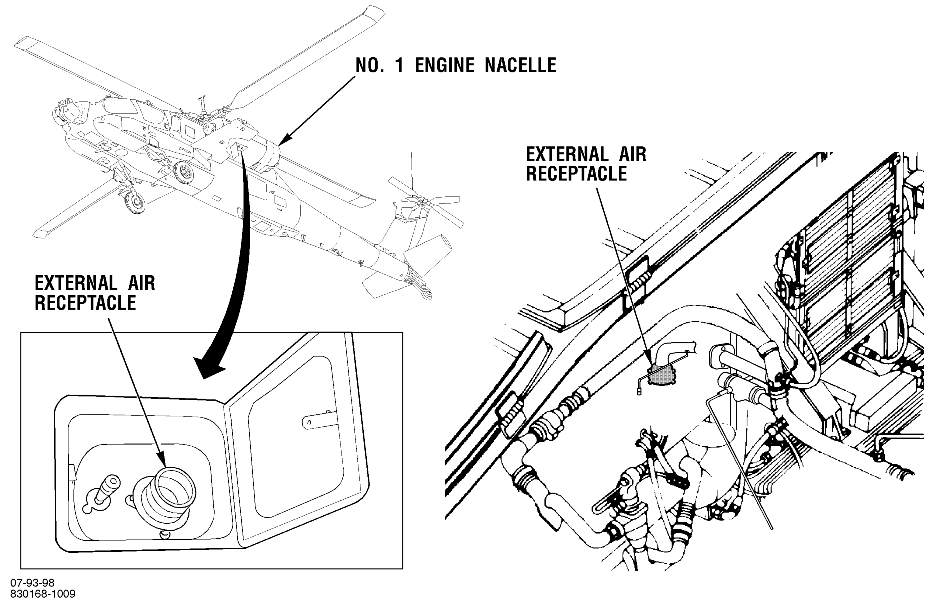
   f. Engine bleed air overcomes the spring force and forces the poppet valve open.

   g. No. 1 engine bleed air pressurizes the PAS manifold.

   h. This action takes place after every flight, when the APU is being started prior to engine shutdown. Starting the APU causes the 60-second time delay relay for the inlet throttle valve to partially shut down the SDC for APU start. No. 1 engine fifth-stage bleed air is then providing PAS air to the manifold.

   i. The position of the poppet valve may be viewed through the sight disk, for troubleshooting purposes.

EXTERNAL AIR SOURCE COMPONENT



NOTES

D. External air source

1. External air is used for maintenance or for starting engines without the APU being on-line.

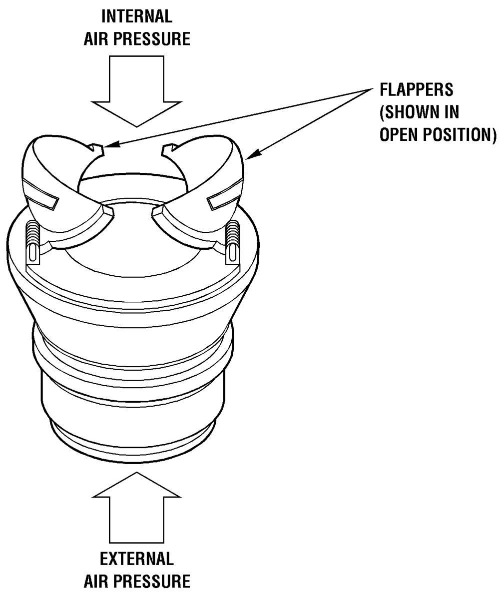
2. The major external air source component is the external air receptacle.

   a. Provides the means to connect an external air source (AGPU) to the helicopter.

   b. Located on the bottom of No. 1 engine nacelle.

   c. One-way corrosion-resistant check valve with a titanium nipple.

EXTERNAL AIR RECEPTACLE OPERATION



07-93-99
83-1010

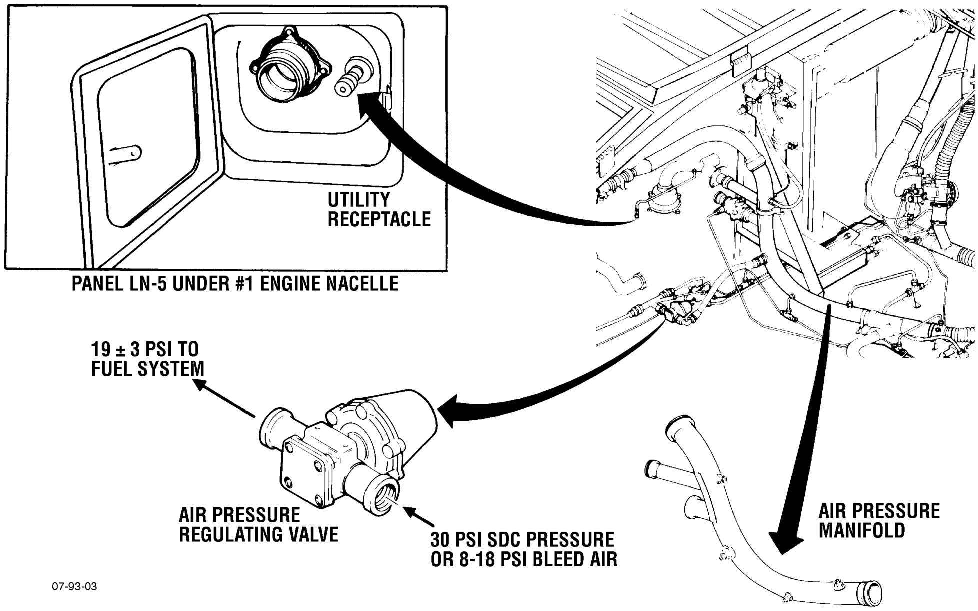
NOTES

d. External air receptacle operation

(1) When external air pressure is applied, the check valve flappers open against spring force to pass air to the PAS manifold.

(2) When external air is removed, spring force closes the check valve flappers, preventing loss of manifold air overboard.

AIR OUTPUT COMPONENTS



NOTES

E. Air output system

1. Major components

a. Air pressure manifold

b. Utility air receptacle

c. Air pressure regulating valve

2. Component description

a. Air pressure manifold

(1) Mounted on the aft equipment bay deck.

(2) Receives the air from one of the sources and distributes it to the user systems and components.

(3) Aluminum alloy tube with inlet and outlet ports.

b. Utility air receptacle

(1) Located on the bottom of No. 1 engine nacelle.

(2) Allows the use of a low-pressure 30 psi (207 kPa) air hose with test equipment when the manifold is pressurized.

(3) Brass, female quick-disconnect coupling.

(4) The system pressure can be checked by installing an air pressure gage to the utility air receptacle.

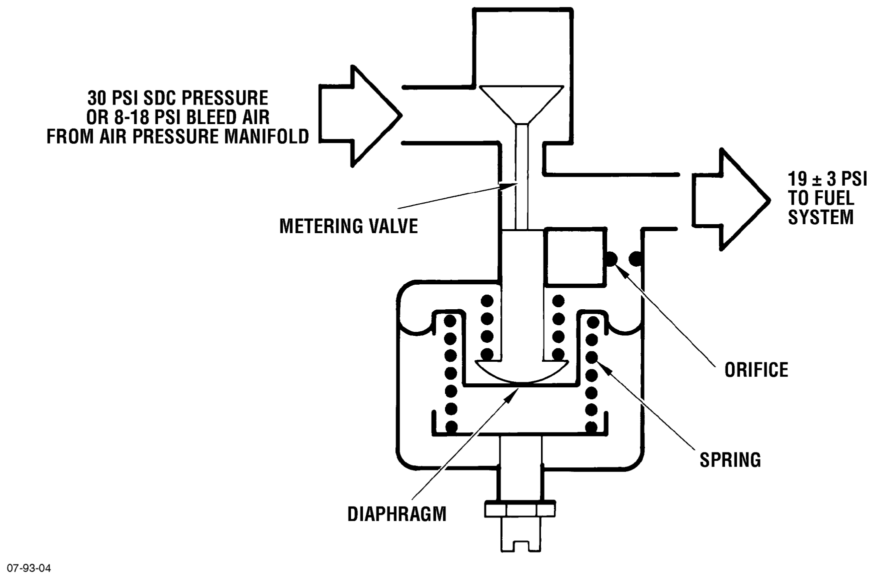
c. Air pressure regulating valve

(1) Located on the floor of the aft equipment bay, aft of the bleed air shutoff valve, under the ENCU.

(2) Reduces manifold pressure to 19 "3 psi (131 "20.6 kPa) for the fuel system.

(3) A normally open, diaphragm-operated, pneumatically controlled metering valve in an aluminum housing.

AIR PRESSURE REGULATING VALVE OPERATION



NOTES

d. Air pressure regulating valve operation

(1) Inlet pressure from the air pressure manifold is ported through the spring-loaded, diaphragm-operated metering valve.

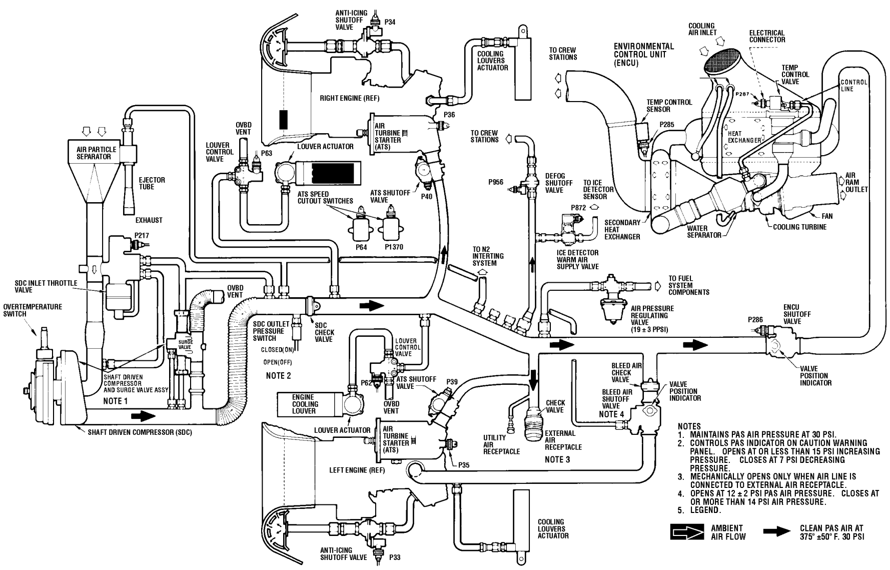
(2) The metered outlet pressure downstream of metering valve is sensed through an orifice by a spring-balanced diaphragm.

(3) When outlet pressure reaches 19 "3 psi (131 "20.6 kPa), the pressure on the diaphragm keeps the spring forces on the metering valve and diaphragm balanced.

(4) If outlet pressure drops below 19 psi (131 kPa), the larger springs pressure move the diaphragm to open the metering valve further.

(5) When outlet pressure rises to 19 psi (131 kPa), the sensed pressure on the diaphragm causes the metering valve to partially close, maintaining a constant pressure of 19 "3 psi (131 "20.6 kPa).

PRESSURIZED AIR SYSTEM



07-93-05

NOTES

F. PAS operation

1. Primary mode

a. With the APU or the engines driving the SDC, ambient air is drawn through the air particle separator and cleaned.

b. The clean air then passes to the SDC inlet throttle valve which is open, except during the APU start.

c. The SDC then compresses the air to 30 psi (207 kPa) and raises the temperature to approximately 400EF (204EC).

d. The surge valve maintains a constant pressure in the PAS system.

e. The hot pressurized air is then routed to the air pressure manifold, where it is distributed to the user systems.

2. Secondary mode

a. In the event SDC outlet pressure drops below 14 psi (97 kPa), the bleed air shutoff valve opens and allows bleed air from No. 1 engine to enter the air pressure manifold. This bleed air is rated at 8 - 18 psi (55.2 - 124.2 kPa) with No. 1 engine operating at 100% N_r, main rotor blades at flat pitch, at sea level. Bleed air pressure varies depending on the No. 1 engine power setting and altitude.

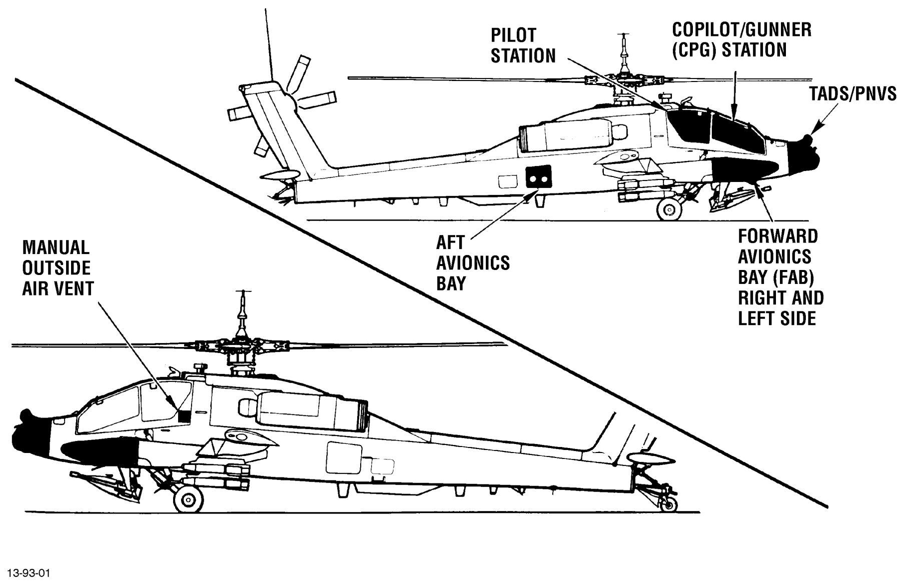
b. The air pressure manifold then distributes the bleed air in the same manner as SDC air.

3. External mode

a. The external air receptacle allows high-pressure air from an AGPU to enter the air pressure manifold.

b. The air pressure manifold distributes the external air in the same manner as the SDC air.

AREAS SUPPLIED BY ECS AIR



NOTES

A. Environmental control system (ECS)

1. The ECS provides conditioned air for the crew stations, FABs, and exhaust fans for the electrical power distribution center and aft avionics bay.

2. Features and capabilities

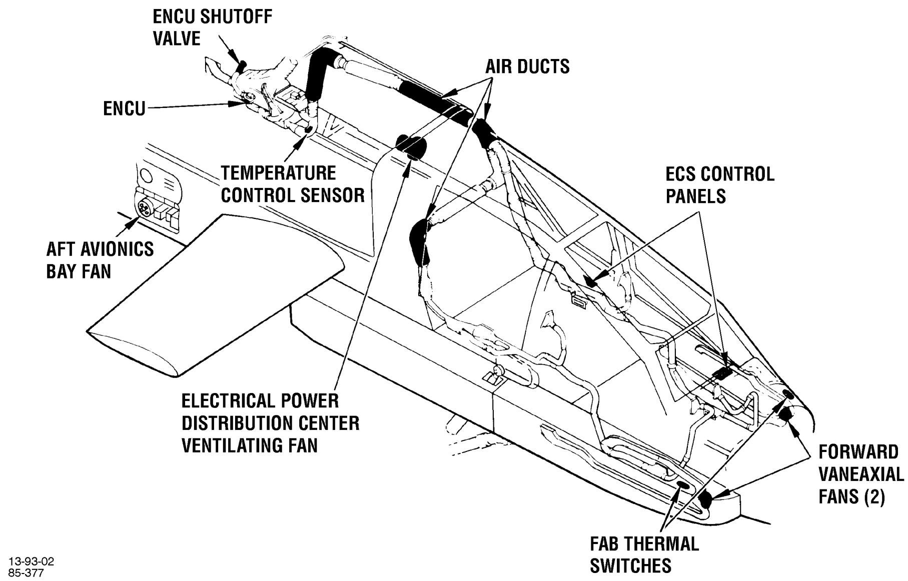
a. Can be operated from the helicopter pressurized air system PAS or an external air source.

b. Utilizes input air pressure of 35 to 60 psi (241 to 414 kPa).

c. Input air up to 400EF (204EC) can be cooled to a temperature of 36EF to 170EF (2EC to 77EC).

d. Manual air vents supplement the ECS by providing ambient ram air to the pilot's crewstation.

ECS COMPONENTS LOCATION



NOTES

3. Major components

   a. ECS control panels

   b. ENCU shutoff valve

   c. ENCU

   d. Temperature control sensor

   e. FAB thermal switches

   f. Air ducts

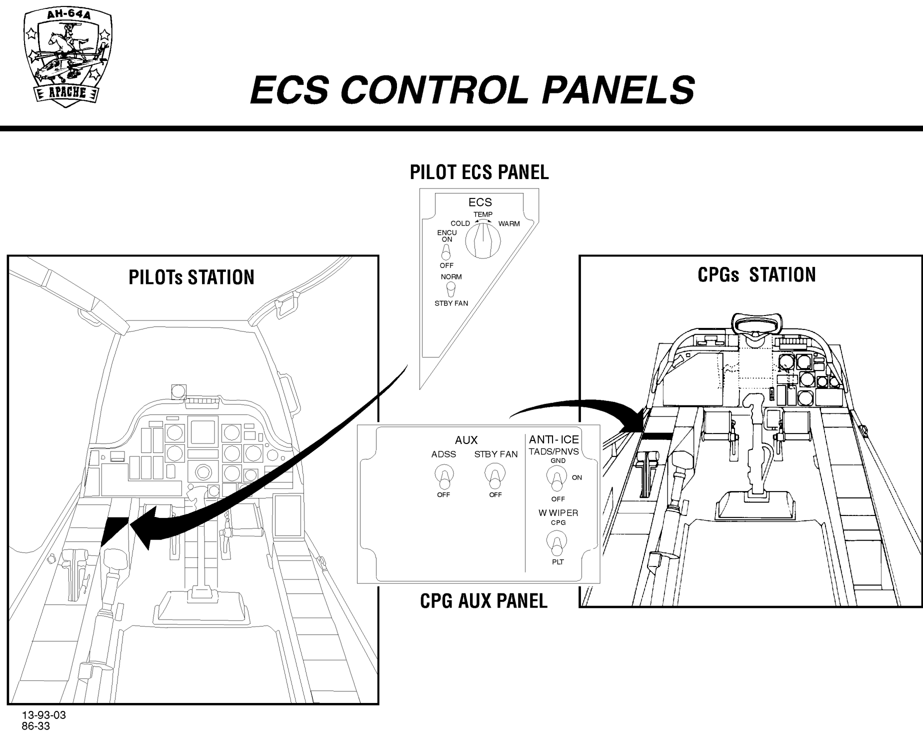
   g. Fans

      (1) Forward vaneaxial fans (2)

      (2) Aft avionics bay fan

      (3) Electrical power distribution center ventilating fan

ECS CONTROL PANELS



NOTES

B. Component description

1. ECS control panels

a. Provides pilot with the means to control the ECS. Both crew members control the speed of the FAB fans.

b. The pilot's ECS control panel is located on the left console in the pilot's crewstation.

c. The CPG's AUX control panel is located on the left console in the CPG's crewstation.

d. The pilot's ECS control panel has the:

(1) ENCU ON/OFF switch

(2) TEMP select switch

(3) NORM/STBY FAN switch

e. The CPG's AUX/ANTI-ICE PANEL has the STBY FAN/OFF switch.

f. Operation

(1) Pilot's ECS control panel

(a) ENCU switch - two position toggle switch.

1) ON - supplies 28 VDC operating voltage to the temperature control sensor and supplies 28 VDC to energize the ENCU shutoff valve open.

2) OFF - removes 28 VDC from the temperature control sensor and the ENCU shutoff valve.

(b) ECS TEMP select switch - rotary switch/rheostat.

1) COLD - allows a minimum ECS air temperature of 36EF (2EC).

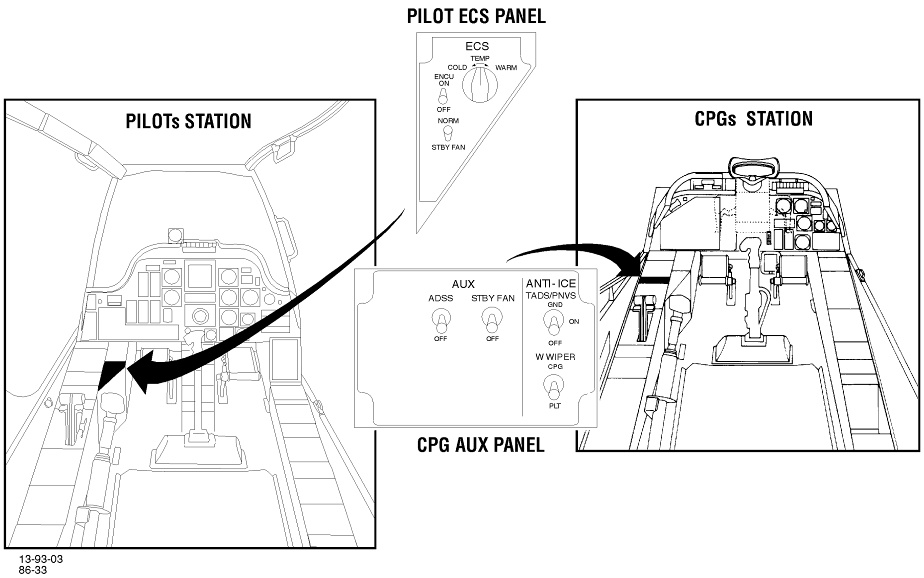
2) WARM - allows a maximum ECS air temperature of 170EF (77EC).

(c) NORM/STBY FAN switch - two-position toggle switch.

1) NORM - FAB fans operate at low speed.

2) STBY - FAB fans operate at high speed.

ECS CONTROL PANELS



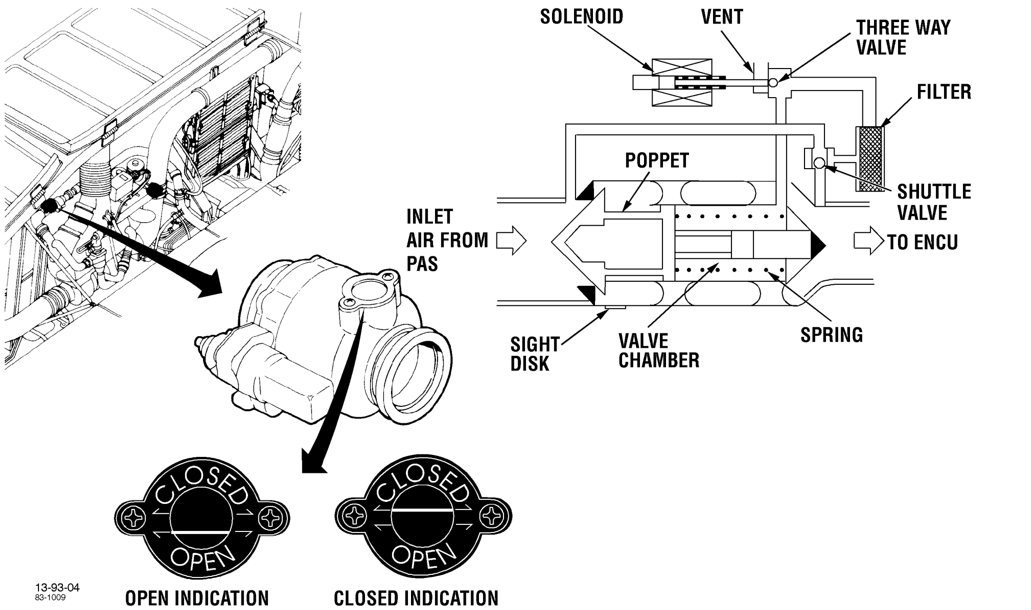
NOTES

(2) CPG's AUX/ANTI-ICE control panel - STBY FAN/OFF switch

(a) STBY - FAB fans operate at high speed.

(b) OFF - FAB fans are controlled by pilot's STBY FAN switch.

ENCU SHUTOFF VALVE



NOTES

2. ENCU shutoff valve

   a. Provides control of input pressurized air to the ENCU.

   b. Located in the aft equipment bay in the ENCU inlet duct.

   c. The ENCU shutoff valve is normally closed, pneumatically operated, solenoid controlled, poppet valve with a valve position indicator.

   d. Operation

      (1) Pneumatic operation

         (a) De-energizing the solenoid allows inlet pressurized air to flow from the inlet into a passage around the poppet piston, through the shuttle valve and filter, and into the valve chamber equalizing pressure on both sides of the poppet piston.

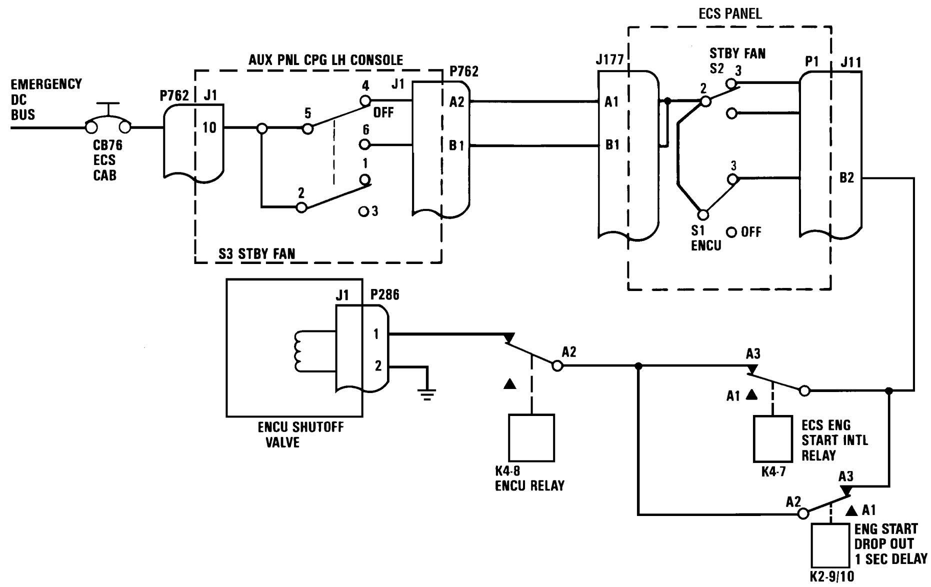
         (b) With equal pressure on both sides, spring tension moves the poppet to the closed position and shuts off air flowing to the ENCU. The visual indicator shows the valve closed.

         (c) Energizing the solenoid closes the three-way valve which stops air from entering the valve chamber and vents the chamber.

         (d) Input air pressure, acting on the poppet piston, overcomes the spring tension and forces the valve open. Air now flows through the valve chamber and out to the ENCU. The visual indicator shows the valve open.

         (e) The valves open or close in a maximum of 1.0 second with an inlet pressure of 25 to 50 psi (172 to 345 kPa).

ENCU SHUTOFF VALVE ELECTRICAL OPERATION



13-93-05
86-32
APRIL 1986 (REV 1)

NOTES

(2) Electrical operation

(a) 28 VDC is available from the emergency DC Bus to the CPG's STBY FAN switch (S3) via the ECS cabin (CAB) Circuit Breaker.

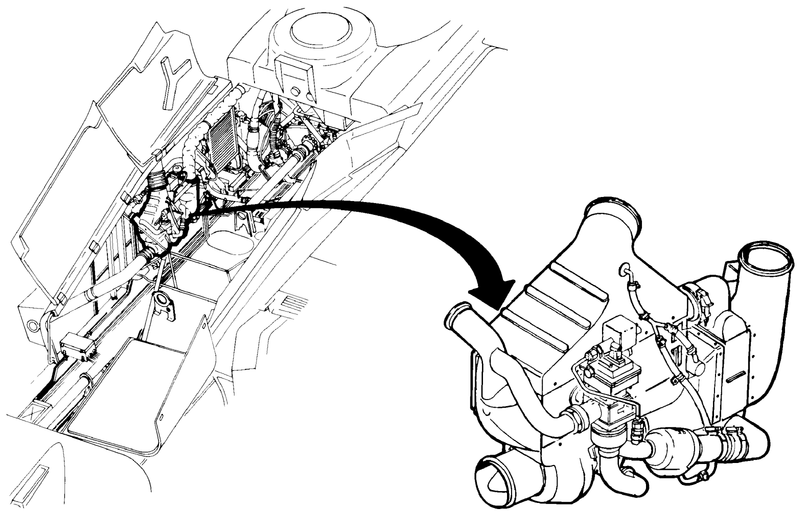
(b) With S3 in the OFF position, power is available to the pilot's ENCU switch (S1) through pin A1 of J177. With S3 in the STBY FAN position, 28 VDC is applied to S1 via pin B1 of J177.

(c) When S-1 is placed in the ON position, power is applied to the ENCU SHUTOFF valve via a parallel circuit consisting of the normally closed contacts of the ECS ENG START INTL RELAY and the ENG START DROP OUT 1 SEC DELAY RELAY, and a series circuit consisting of the de-energized closed contacts of the ENCU RELAY. With power applied to the ENCU VALVE, air pressure forces the valve open and the ENCU is operational.

(d) When an engine start is initiated, the ENCU SHUTOFF VALVE is de-energized closed to ensure all of the PAS air is available to rotate the engine. The ECS ENG START INTL RELAY is energized open immediately upon start initiation, but power is not removed from the ENCU SHUTOFF VALVE until the ENG START DROP OUT RELAY energizes one second after the engine start is initiated. The one second delay prevents surges in the PAS system by ensuring the AIR TURBINE STARTER VALVE is open prior to closing the ENCU SHUTOFF VALVE.

(e) The ENCU RELAY is energized when either engine FIRE PULL HANDLE is activated. Power is removed from the ENCU SHUTOFF VALVE, allowing the valve to close. This ensures that all PAS air is available to close the engine louvers.

ENCU



13-93-06
85-366

NOTES

3. Environmental Control Unit

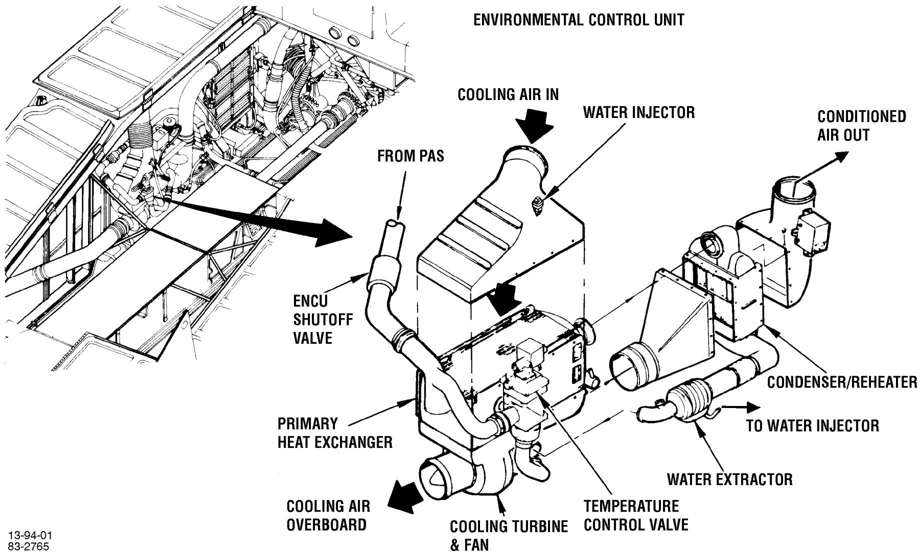
CAUTION

During ENCU control unit removal, installation, ensure there is no chafing between the ENCU, and the fire extinguisher tubing. Failure to do so could cause a malfunction of the ECS or fire extinguishing systems.

a. Supplies conditioned air for cooling and heating the crew stations and avionics bays by extracting heat energy from the PAS air.

b. The ENCU is located in the aft equipment bay on the left side.

ENCU COMPONENTS



NOTES

c. ENCU assembly components

(1) PAS air inlet

(2) ENCU shutoff valve

(3) Primary heat exchanger with cooling air inlet and water injector

(4) Condenser reheater

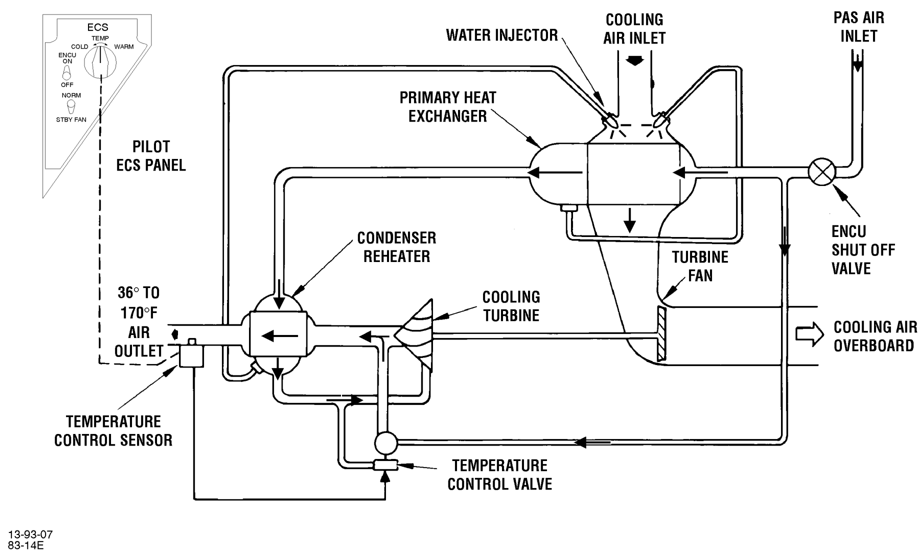
(5) Temperature control sensor

(6) Cooling turbine

(7) Temperature control valve

(8) Turbine fan with cooling air overboard outlet

ENCU OPERATION



NOTES

d. ENCU operation

(1) Hot PAS air flows through the ENCU shutoff valve and is ducted to the primary heat exchanger and the temperature control valve.

(2) The PAS air flows through the heat exchanger where it becomes partially cooled on its way to the condenser-reheater.

(3) The condenser-reheater further cools the partially cooled PAS air and collects condensation.

(4) Air pressure routes the condensation to the water injectors which sprays it into the cooling ram air inlet of the heat exchanger to increase the cooling efficiency.

(5) The cooled air is ducted from the condenser-reheater to the cooling turbine fan assembly for the final stage of cooling.

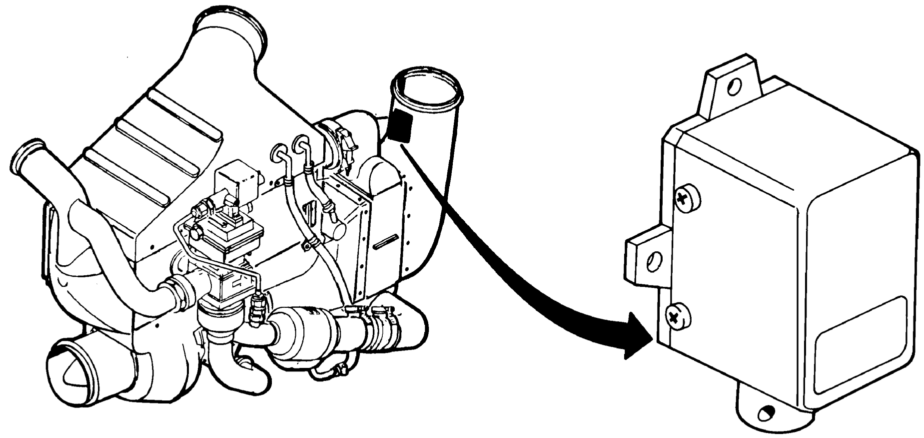
(6) The turbine extracts more heat energy from the air and drives the fan.

(7) The fan draws ambient air through the primary heat exchanger and exhausts its overboard.

(8) The hot PAS air which has bypassed the heat exchanger is available to the temperature control valve.

(9) The temperature control valve modulates to mix hot PAS air with the cooled turbine discharge air to maintain the temperature selected by the pilot.

TEMPERATURE CONTROL SENSOR



13-93-08
83-15-1

NOTES

4. Temperature control sensor and FAB thermal switches

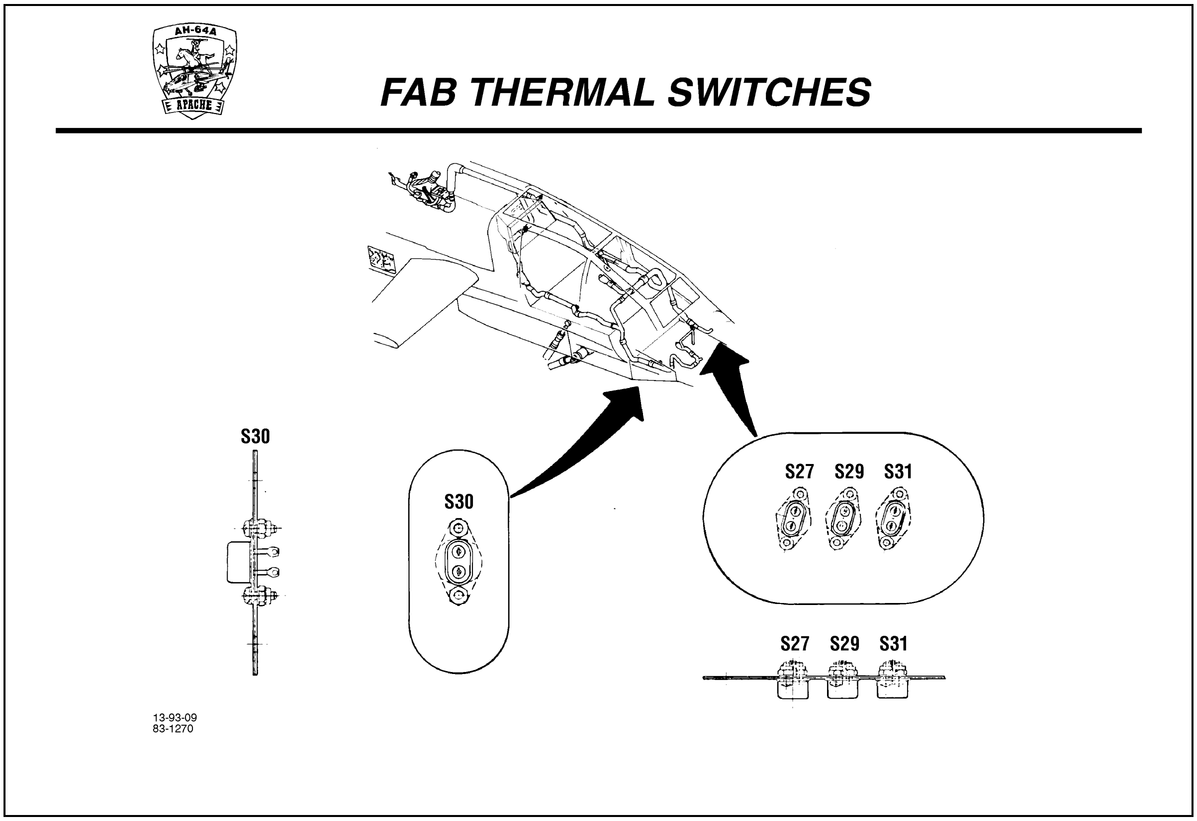
   a. Temperature control sensor

      (1) The temperature control sensor positions the temperature control valve to maintain the selected temperature in the crew stations.

      (2) Located in the outlet duct of the ENCU.

      (3) The temperature control sensor is a solid state electrical device with two sensing elements. It receives inputs from the ECS panel and the FAB thermal switches and monitors ENCU air outlet temperature.

NOTES


AH-64A
APACHE
FAB THERMAL SWITCHES
S30
S30
S27 S29 S31
S27 S29 S31
13-93-09
83-1270

b. FAB thermal switches

(1) Switch S-27 and S-29 provide a signal to the temperature control sensor when the temperature in the left FAB reaches:

(a) S-27 - 75EF (24EC).

(b) S-29 - 85EF (29EC).

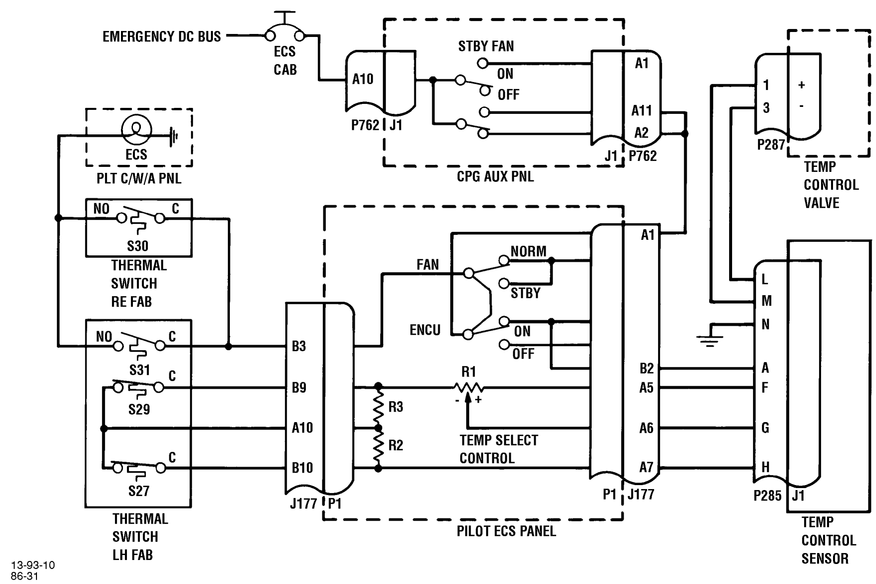
(2) Switch S-30 and S-31 provide a signal to turn on the ECS caution light on the pilot's C/W/A panel if the temperature in either FAB reaches 105EF (41EC).

(3) Switches S-27, S-29, and S-31 are located in the left FAB.

(4) Switch S-30 is located in the right FAB.

(5) The switches are inspected during phase maintenance inspections.

TEMPERATURE CONTROL SENSOR ELECTRICAL INTERFACE



NOTES

c. Operation of temperature control sensor and FAB thermal switches

(1) 28 VDC from the ECS CAB (CB76) circuit breaker is routed through the CPG AUX PNL to the ENCU switch on the pilot's ECS panel. When the ECS switch is placed in the ON position, 28 VDC is applied to pin A of the ENCU temperature control sensor. This is the excitation voltage for the sensor.

(2) The pilot uses the TEMP select knob to set the desired temperature. Moving the TEMP select knob either increases or decreases the reference voltage to the ECS temperature control sensor.

(a) Rotating the knob counterclockwise increases the resistance. This decreases the reference voltage to the TEMP CONTROL SENSOR.

(b) Rotating the knob clockwise decreases the resistance and increases the reference voltage.

(3) The temperature control sensor:

(a) Accepts electrical signals from the temperature select switch on the pilot's ECS CONTROL PANEL and two thermal switches in the left FAB.

(b) Monitors the temperature of the air in the outlet duct of the ENCU and develops a reference voltage proportional to the temperature of the air.

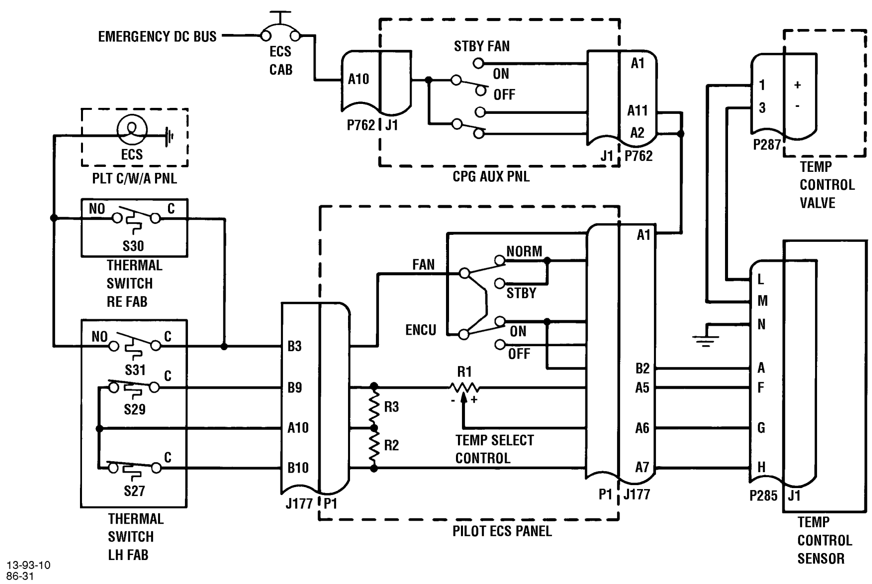
(4) The temperature control sensor processes the reference voltage from the TEMP select knob and the air temperature reference voltage, and applies an output voltage to the temperature control valve.

(5) The output voltage is proportional to the difference between the selected temperature and the duct outlet air temperature, and causes the temperature control valve to position so that the selected temperature is maintained.

(6) The temperature control circuit includes two fixed resistors (R2 and R3) and two thermal switches (S-29 and S-27). R2 and R3 are located in the ECS panel and S-29 and S-27 are mounted on a common bracket in the left FAB.

(7) If the temperature in the left FAB is below 75EF (24EC), both switches are closed. This shorts out the two fixed resistors, leaving only the position of the TEMP select knob to establish the temperature reference voltage applied to the ECS temperature control sensor.

TEMPERATURE CONTROL SENSOR ELECTRICAL INTERFACE



NOTES

(8) When the temperature in the FAB reaches 75EF (24EC), one of the switches opens. This action puts one of the fixed resistors in series with the reference voltage established by the TEMP select knob.

(9) With the increase in resistance, the temperature control sensor feels a reduction in the reference voltage and signal the temperature control valve to decrease the ENCU output temperature by 15EF (9EC).

(10) If the temperature in the left FAB reaches 85EF (29EC), the other thermal switch opens.

(11) This results in both fixed resistors being added in series with the TEMP select voltage, further reducing the reference voltage to the ECS temperature control sensor.

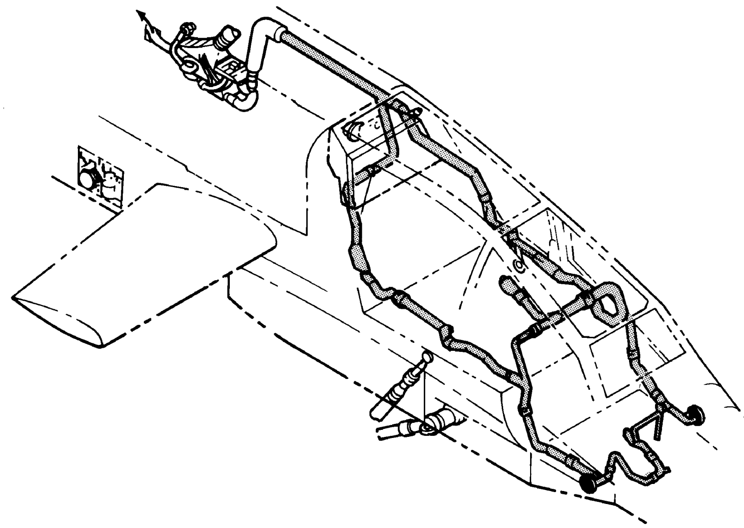
(12) The sensor signals the temperature control valve to reduce the ENCU output by an additional 15EF (9EC).

(13) As the temperature in the left FAB reduces, the thermal switches close (one at 84EF (9EC) - one at 74EF (23EC)) and control of the ENCU temperature reverts to the TEMP select knob.

(14) The left FAB contains an additional thermal switch (S-31), and the right FAB contains one thermal switch (S-30). These two switches are identical and close at 105EF (40EC). If either switch closes, it complete the circuit that illuminates the ECS warning light on the pilot's C/W/A panel.

071-

AIR DUCTS



NOTES

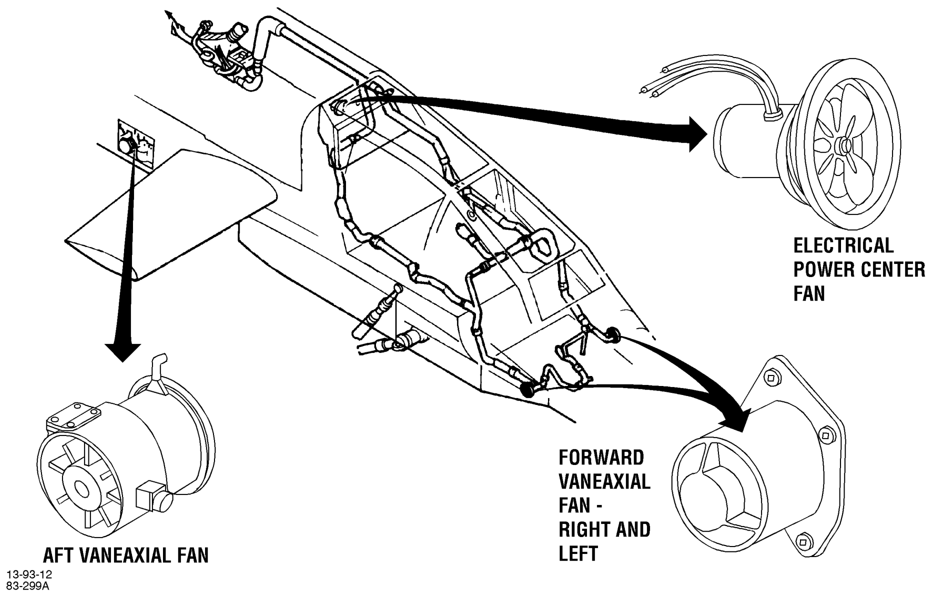
5. Air ducts

   a. Duct air from the ENCU to the crew stations and the FABs.

   b. The air duct begins at the ENCU outlet and extends forward to the CPG's crewstation.

   c. The air duct is made of kevlar and consists of 22 different sections with air outlets in each crewstation.

VANEAXIAL AND VENTILATING FANS



NOTES

6. Vaneaxial and ventilating fans

   a. The vaneaxial fans circulate cooling air around electronic and electrical equipment in the avionics bays and the ventilating fans ventilate the electrical power distribution center and aft avionics bay.

   b. One vaneaxial fan is located in each FAB.

   c. One vaneaxial fan is located in the aft avionics bay. It is an exhaust fan used to ventilate the aft avionics bay.

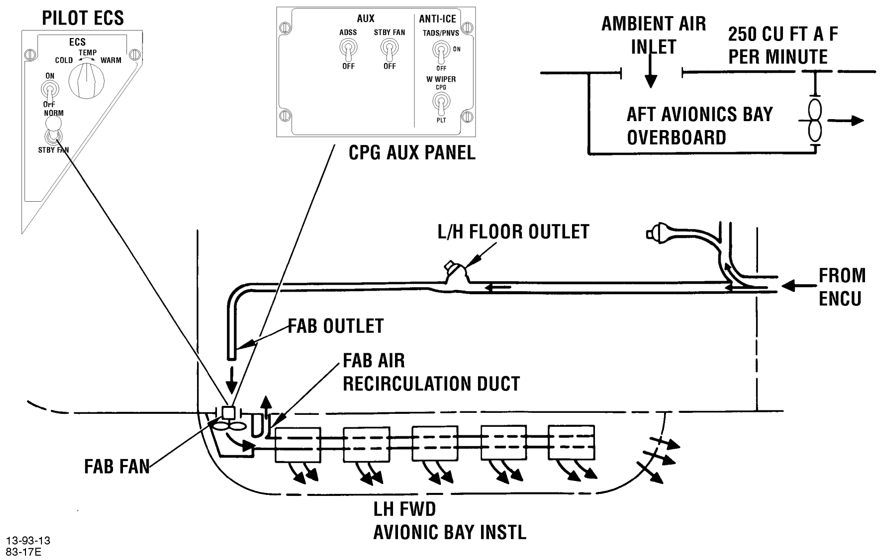
   d. One ventilating fan is located in the electrical power distribution center.

   e. The FAB fans are tubular in design with the fan and a 115/200 VAC, three-phase, 2 speed motor in the center. The fan does not have an electrical connector.

   f. The aft avionics bay fan is tubular in design with the fan and single-speed, 115/200 VAC, three-phase motor in the center. It has an electrical connector.

   g. The electrical power distribution center ventilating fan is a tubular design with the fan in the rear. The single-speed 115/200 VAC, three-phase motor 115/200 VAC motor does not have an electrical connector.

AVIONICS BAY FAN OPERATION



NOTES

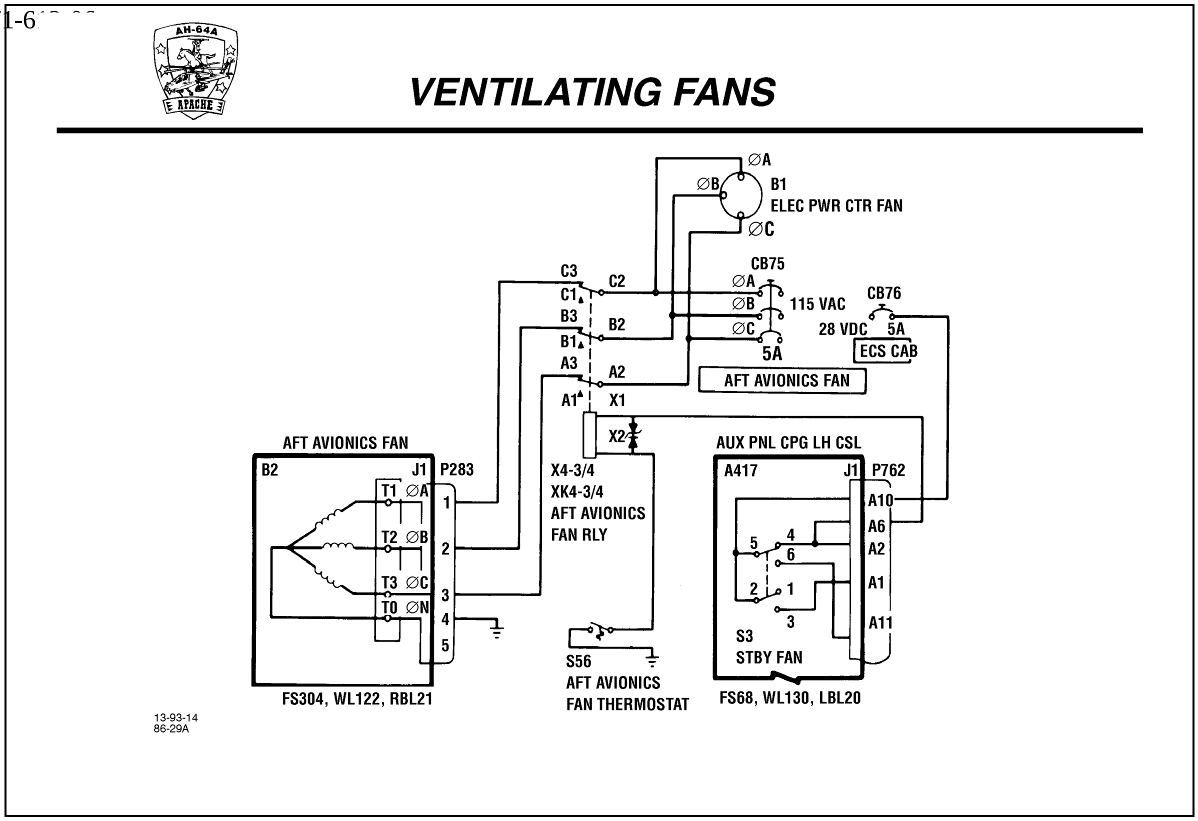
h. Air flow

(1) The FAB fans are two-speed fans.

(a) NORM (low) speed - airflow is 137.7 cubic feet per minute.

(b) STBY (high) speed - airflow is 270.0 cubic feet per minute.

(2) The aft avionics bay fan is a single speed-fan - airflow is 250 cubic feet per minute.


AH-64A
APACHE
VENTILATING FANS
ØA
ØB
B1
ELEC PWR CTR FAN
ØC
CB75
C3
C1
C2
ØA
ØB
115 VAC
CB76
B3
B2
ØC
28 VDC
5A
B1
5A
ECS CAB
A3
A2
AFT AVIONICS FAN
A1
X1
X2
AFT AVIONICS FAN
AUX PNL CPG LH CSL
B2
J1
P283
A417
J1
P762
T1 ØA
T2 ØB
T3 ØC
T0 ØN
1
2
3
4
5
X4-3/4
XK4-3/4
AFT AVIONICS
FAN RLY
A10
A6
A2
A1
A11
5
4
6
2
1
3
S3
STBY FAN
S56
AFT AVIONICS
FAN THERMOSTAT
FS304, WL122, RBL21
FS68, WL130, LBL20
13-93-14
86-29A

NOTES

i. Ventilating fans operation

(1) Electrical power distribution center fan

(a) The electrical power distribution center fan is connected directly to the AFT AVIONICS FAN circuit breaker.

(b) When AC power is available and the circuit breaker is closed, the fan is operating.

(2) Aft avionics bay vaneaxial fan

(a) The crew has no direct control of the aft avionics bay fan, however, it is controlled automatically by a thermal switch which energizes or de-energizes the aft avionics fan relay.

(b) If power is applied to the helicopter, three-phase AC from the AFT AVIONICS circuit breaker (CB 75) is available to the normally closed contacts of XK-4, the AFT AVIONICS FAN RELAY.

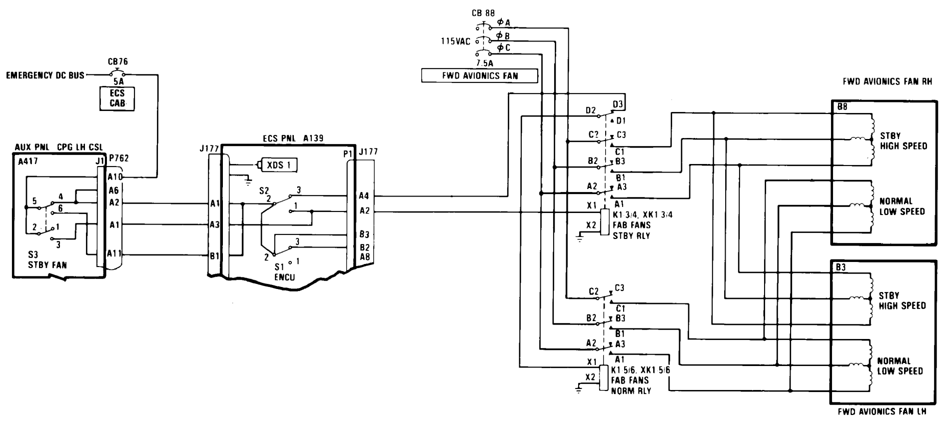
(c) If the temperature in the bay is 25EF (-4EC) or above, the thermal switch is opened, the relay is de-energized, and three-phase AC is connected to the fan.

(d) If the temperature in the bay decreases to 10EF (-12EC), the thermal switch closes, completing the circuit for the coil of the AFT AVIONICS FAN RELAY.

(e) The relay energizes, removing three-phase power from the fan motor.

(f) As the temperature varies from 10EF (-12EC) to 25EF (-4EC), the fan motor cycles automatically.

FAB FANS
ELECTRICAL SCHEMATIC



13-93-15
86-30A
JULY 1986 (REV 2)

NOTES

(3) Forward avionics bay fans

(a) The FAB fans cannot be turned off by the crew (except by pulling the ECS circuit breaker), but the speed of the fans can be controlled from either crewstation.

(b) DC control power is available from the ECS circuit breaker and AC power for fan operation is available from the FWD AVIONICS FAN circuit breaker.

(c) DC power is routed from the circuit breaker to the CPG's STBY FAN switch. The switch is a two position switch, NORM and OFF.

(d) With the switch in NORM, power is routed to the pilot's STBY FAN switch through contacts 5/4.

(e) If the OFF position is selected, power is routed through contacts 2/3, out pin A1 of P762 and into the pilot's ECS panel pin A3 of J177 and out pin A2 of J177 to the coil of the FAB FANS STBY RELAY. The relay energizes, which causes the FAB FANS NORM RELAY to de-energize. The FAB FANS STBY RELAY, when energized, connects three-phase, 115/200 VAC to the STBY HIGH SPEED motor winding to operate the fan motor at high speed.

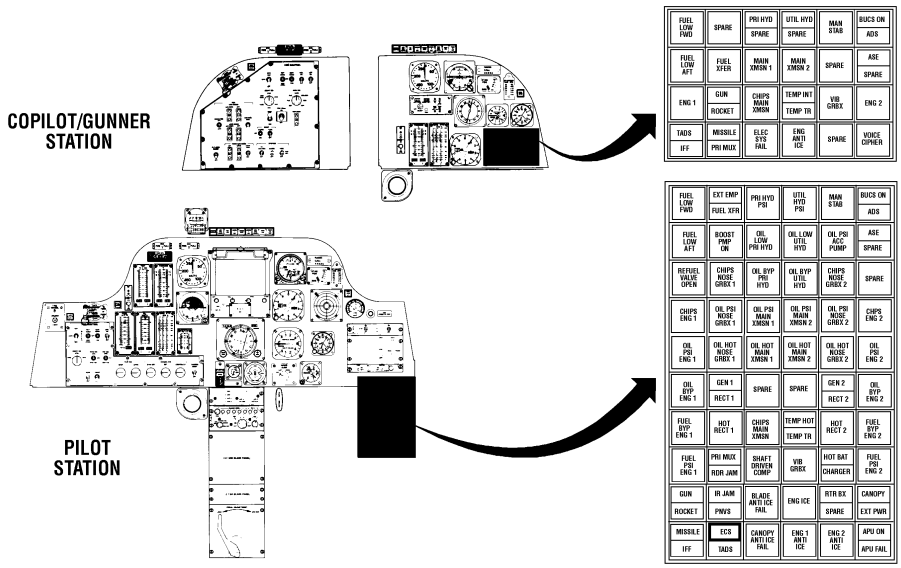
(f) With the CPG's STBY FAN switch in the STBY FAN position, the pilot's STBY FAN switch has no effect on fan operation.

(g) With the CPG's STBY FAN switch in the NORM position, the speed of the FAB motors is controlled by the pilot's STBY FAN switch.

(h) When the pilot's STBY FAN switch is in the NORM position, 28 VDC is routed out A4 of J177, through de-energized closed contacts D3/D2 of the FAB FANS STBY RELAY and to the coil of the FAB FANS NORM RELAY. The relay energizes and connects three-phase, 115/200 VAC to the NORMAL LOW SPEED motor windings.

(i) When STBY is selected, power is removed from the FAB FANS NORM RELAY and applied to the coil of the FAB FANS STBY RELAY, connecting AC power to the HIGH SPEED motor winding.

CAUTION/WARNING/ ADVISORY PANELS



15-93-36

NOTES

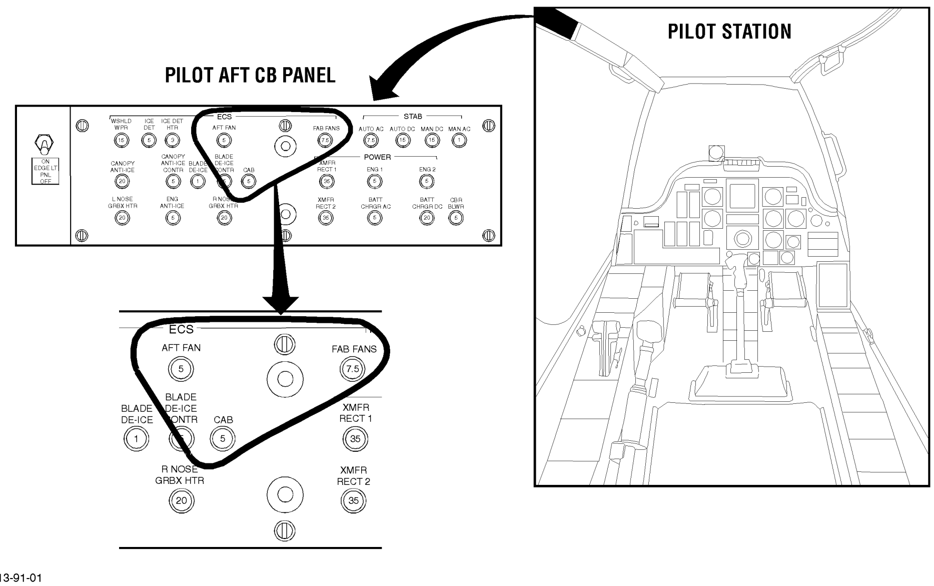
7. ECS Caution Light

   a. When illuminated, the pilot is advised that the ECS system may have malfunctioned. (The ECS caution light may illuminate if the ECS is not capable of cooling the FABs due to extreme ambient conditions. This is not a failure of the system.)

   b. Located on the pilot's C/W/A panel.

   c. Amber colored light that illuminates if the bay temperature reaches 105 degrees F.

ECS CIRCUIT PROTECTION



NOTES

8. ECS Circuit Protection

a. ECS Aft Fan CB

(1) Provides circuit protection for the Electrical Power Center Fan and the Aft Avionics Bay Vaneaxial Fan.

(2) Located on the pilot's Aft circuit breaker panel (CB 75).

(3) Three-phase 115/200 VAC rated at 5 amps and receives power from the 115/200 VAC essential bus 2.

b. ECS CAB CB

(1) Provides circuit protection for the CPG Auxiliary/Anti-ice Control Panel and the ECS control panel.

(2) Located on the pilot's aft circuit breaker panel (CB 76).

(3) 28 VDC rated at 5 amps and receives power from the Emergency Bus.

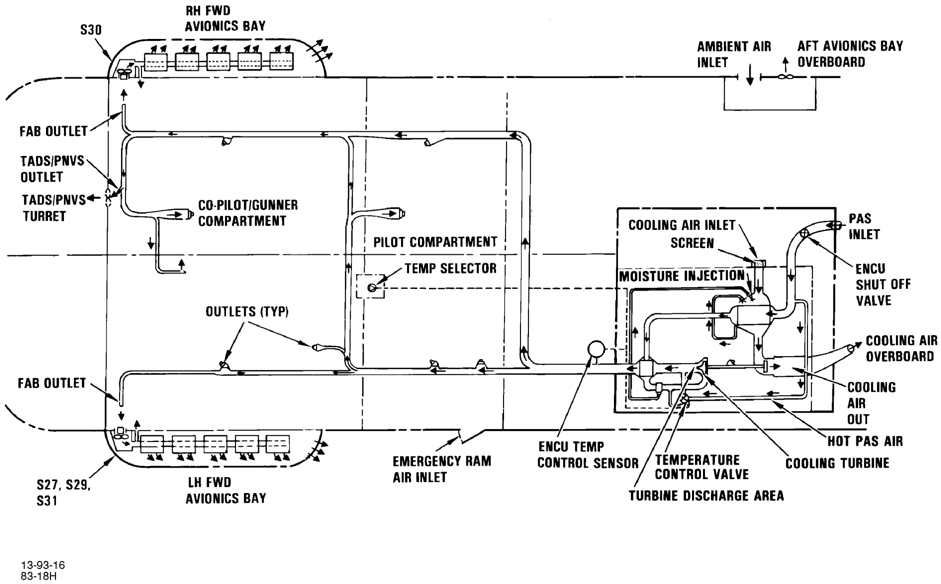
c. ECS FAB Fans CB

(1) Provides circuit protection for the Left and Right Vaneaxial Fan.

(2) Located on the pilot's AFT circuit breaker panel (CB 88).

(3) Three phase 115/200 VAC rated at 7.5 amps and receives 115/200 VAC from the Essential Bus 2.

ECS SYSTEM OPERATION



NOTES

C. ECS System operation

1. Hot PAS air enters the ENCU through the ENCU shutoff valve.

2. The hot air enters the heat exchanger where it is cooled to a temperature that is near ambient temperature.

3. The hot air is cooled by the ram cooling air being drawn across the heat exchanger core by the turbine fan.

4. Further cooling is caused by the water being injected into the heat exchanger ram cooling air inlet from the primary heat exchanger core.

5. The partially cooled air flows to the condenser-reheater where further temperature reduction occurs and moisture is condensed and returned to the heat exchanger ram cooling air inlet.

6. The air passes to the cooling turbine which expands the compressed air and reduces the temperature to a point below freezing.

7. To prevent the condenser-reheater from freezing and blocking airflow to the crewstation, the temperature control sensor causes the temperature control valve to open.

8. The temperature control valve has hot PAS air available and mixes it with cold air at the turbine discharge area.

9. The temperature control sensor limits the temperature leaving the condenser-reheater to a minimum of 36EF (2EC).

10. To maintain a desired temperature, the pilot makes a selection on the ECS TEMP control switch.

11. This selection informs the temperature control sensor of the desired temperature.

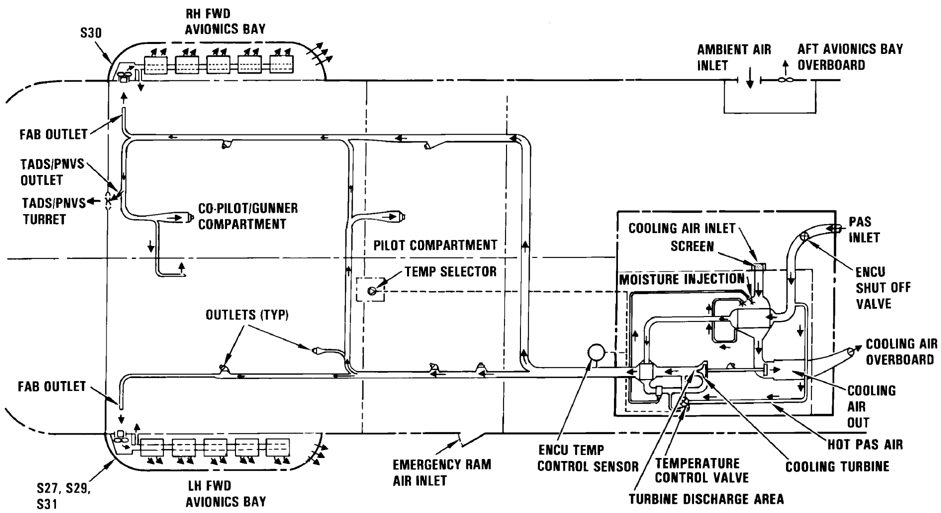
12. The sensor, sensing duct temperature going to the crewstation and knowing the desired temperature, causes the temperature control valve to mix the appropriate amount of hot air with the cold air to maintain selected temperature.

13. The conditioned air flows to the crew stations where it maintains crew comfort and cools electronic gear.

14. The FAB fans draw the air from the CPG's crewstation and route it through the avionics gear before exhausting it overboard.

15. If FAB temperature reaches 75EF (24EC), S27 signals the temperature control sensor to reduce output temperature by 15EF.

ECS SYSTEM OPERATION



13-93-16
83-18H

NOTES

16. If FAB temperature reaches 85EF (29EC), S29 calls for an additional 15EF reduction.

17. Should the bay temperature reach 105EF (41EC), the ECS light on the pilot's C/W/A panel illuminates.